THE STANDARD CYCLOPEDIA OF MODERN AGRICULTURE

THE STANDARD CYCLOPEDIA OF MODERN AGRICULTURE AND RURAL ECONOMY

AN ENGLISH FARMYARD

THE STANDARD CYCLOPEDIA OF MODERN AGRICULTURE AND RURAL ECONOMY

BY THE MOST DISTINGUISHED
AUTHORITIES AND SPECIALISTS
UNDER THE EDITORSHIP OF

PROFESSOR R. PATRICK WRIGHT

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LIST OF PLATES

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LIST OF CONTRIBUTORS

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The contributors sign by their initials at the conclusion of their respective articles. Those in the present volume are as follows:—

A. C. F.	**Arthur C. Forbes**, F.H.A.S., Expert in Forestry to the Department of Agriculture for Ireland; Author of "English Estate Forestry", &c.
A. M'N.	**Archibald M'Neilage**, Editor, *Scottish Farmer*; Secretary, Clydesdale Horse Society.
A. N. M'A.	**A. N. M'Alpine**, B. Sc. (Lond.), Assoc. R. C. S., Professor of Botany, West of Scotland Agricultural College, Consulting Botanist to the Highland and Agricultural Society of Scotland; Author of "A Botanical Atlas", &c.
C. B. J.	**C. Bryner Jones**, F.H.A.S., M.R.A.S.E., Lecturer on Agriculture, University College of North Wales, Bangor.
C. C. J.	**C. C. James**, Deputy Minister, Department of Agriculture for Ontario, Canada.
C. W.	**Cecil Warburton**, M.A., F.Z.S., Zoologist to the Royal Agricultural Society of England; Author of "Orchard and Bush Fruit Pests", &c.
D. B.	**David Bruce**, M.A., LL.B., Lecturer in Agricultural Law, West of Scotland Agricultural College.
E. B.	**Edward Brown**, F.L.S., Lecturer on Poultry at the University College, Reading, Secretary of the National Poultry Organization; Author of "Poultry-keeping", &c.
E. J. R.	**Edward John Russell**, D.Sc.(Lond.), F.C.S., Chemist for Soil Investigation at the Rothamsted Experiment Station, Harpenden, Herts.
F. T. B.	**Frank T. Barton**, M.R.C.V.S., Author of "The Practice of Equine Medicine", &c.

F. V. T. — **F. V. Theobald**, M.A.(Cantab.), Vice-Principal and Zoologist at the South-Eastern Agricultural College, Wye, Kent; Author of "A Textbook of Agricultural Zoology", "Reports on Economic Zoology", &c.

G. A. J. C. — **Grenville A. J. Cole**, F.G.S., Professor of Geology in the Royal College of Science, Dublin; Director of the Geological Survey of Ireland; Author of "Aids in Practical Geology", &c.

G. W. — **Sir George Watt**, M.B., C.M., F.L.S., LL.D., Kew, London; Author of "Economic Products of India", &c. &c.

H. E. M. — **The Right Hon. Sir Herbert E. Maxwell**, Bart., F.R.S., LL.D., Lord-Lieutenant of Wigtownshire; Author of "Memories of the Months", &c.

H. L. — **Harold Leeney**, M.R.C.V.S., Author of "Home Doctoring of Animals", "The Lambing Pen", &c.

H. M. C. — **H. Munro Cautley**, A.R.I.B.A., Ipswich.

H. S. H. P. — **H. S. Holmes Pegler**, Secretary of the British Goat Society; Author of "The Book of the Goat".

H. S. R. E. — **Hugh S. R. Elliot.**

J. A. T. — **J. Arthur Thomson**, M.A., Professor of Natural History, Aberdeen University, Examiner in Agricultural Zoology for the National Diploma in Agriculture; Author of "Heredity", &c.

J. A. V. — **J. Augustus Voelcker**, Ph.D., M.A., B.Sc., F.I.C., &c., Consulting Chemist to the Royal Agricultural Society of England.

J. B. — **John Brown**, B.Sc., N.D.A., Lecturer on Agriculture, the West of Scotland Agricultural College, Glasgow.

J. Ca. — **James Cameron**, Agricultural Editor, *Glasgow Herald.*

J. C. N. — **J. C. Newsham**, Principal of the Farm School, Basing, Basingstoke.

J. Co. — Under article BUTYRIC ACID: erratum for J. Go.

J. F. B. — **J. Frank Blackshaw**, F.C.S., Principal of the Midland Agricultural and Dairy Institute, Kingston, Derby.

J. Gi. — **John Gillies**, N.D.A., N.D.D., Instructor under the West of Scotland Agricultural College for the Counties of Kirkcudbright and Wigtown.

J. Gl. — **John Glaister**, M.D., Professor of Medical Jurisprudence and Public Health, the University, Glasgow.

J. Go. — **John Golding**, F.I.C., F.C.S., Head of the Chemical and Bacteriological Departments at the Midland Agricultural and Dairy Institute, Kingston, Derby.

J. H. — **James Hendrick**, B.Sc., F.I.C., F.C.S., Lecturer in Agricultural Chemistry in the Aberdeen University, Chemist to the Highland and Agricultural Society of Scotland, Analyst to the Counties of Aberdeen, Banff, and Nairn.

J. M'C. — **James M'Call**, F.R.C.V.S., Principal of the Glasgow Veterinary College.

J. N.	**John Nisbet**, D.Œc., Editor of "The Forester", "Studies in Forestry", "British Forest Trees", &c.
J. P.	**John Percival**, M.A.(Cantab.), F.L.S., Director of the Agricultural Department, and Professor of Agriculture, University College, Reading; Author of "Agricultural Botany".
J. P. S.	**John Prince Sheldon**, formerly Professor of Agriculture at the Royal Agricultural College, Cirencester; Author of "Dairy Farming", "British Dairying", &c.
J. R.	**John Rennie**, D.Sc., Natural History Department, the University, Aberdeen.
J. R. A. D.	**J. R. Ainsworth Davis**, M.A., F.C.P., Principal of Royal Agricultural College, Cirencester; Author of "The Natural History of Animals".
J. R. M'C.	**John R. M'Call**, M.R.C.V.S., Professor of Pathology and Meat Inspection, Glasgow Veterinary College.
J. S.	**John Spier**, Newton Farm, near Glasgow, Member of the Royal Commission on Tuberculosis, 1897.
J. Wi.	**James Wilson**, M.A., Professor of Agriculture, Royal College of Science, Dublin.
J. Wr.	**John Wrightson**, late Principal of Downton Agricultural College; Author of "Farm Crops", "Sheep Breeding and Feeding", &c.
L. M. D.	**Loudon M. Douglas**, Lecturer on the Meat Industry, East of Scotland Agricultural College, Edinburgh.
P. G. C.	**Major P. G. Craigie**, C.B., formerly Director of the Statistical Intelligence and Educational Department of the Board of Agriculture, and Editor of the Agricultural Returns.
R. A. B.	**Reginald A. Berry**, F.I.C., F.C.S., Professor of Agricultural Chemistry in the West of Scotland Agricultural College; Joint Author of "Soil Analysis", "Selection of Seed by Chemical Methods", &c.
R. B. G.	**R. B. Greig**, F.H.A.S., F.R.S.E., Lecturer on Agriculture, Aberdeen and North of Scotland Agricultural College.
R. H.	**Richard Henderson**, Lecturer on Surveying in the West of Scotland Agricultural College; Author of "The Young Estate Manager's Guide", "The Modern Homestead", &c.
R. H. L.	**Renwick Hutson Leitch**, M.A., B.Sc., N.D.A.(Hons.), the West of Scotland Agricultural College, Glasgow.
R. I. P.	**R. I. Pocock**, F.L.S., F.Z.S., Superintendent of the Zoological Society's Gardens, Regent's Park, London.
R. J. T.	**Robert J. Thomson**, Board of Agriculture and Fisheries.
R. P. W.	**R. Patrick Wright**, F.H.A.S., F.R.S.E., Principal of the West of Scotland Agricultural College; Author of "The Influence of Phosphates on Farm Crops", &c.
S. J. C.	**Sidney J. Chapman**, Professor of Political Economy, Manchester University; Author of "Foreign Competition", &c.

S. S.	**Sanders Spencer**, Author of "Pigs for Breeders and Feeders", "Pigs, Breeds and Management", &c.
T. D. Y.	**T. D. Young**, Chief Inspector of Meat, Deptford Foreign Cattle Market.
T. H.	**T. Hallissy**, B.A., of the Laboratory for the Investigation of Soils, Geological Survey of Ireland.
V. S.	**Vero Shaw**, Author of "How to Choose a Dog", "Don'ts for Dog Owners", &c.
W. B.	**William Barber**, M.A., Tererran, Moniaive.
W. Br.	**Will. Brown**, Assistant Lecturer and Practical Instructor in Poultry Keeping, University College, Reading; Secretary, Departmental Committee on Poultry Breeding in Scotland.
W. G. R. P.	**William G. R. Paterson**, B.Sc., N.D.A.(Hons.), Lecturer on Agriculture, the West of Scotland Agricultural College, and Agricultural Instructor for the County of Dumfries.
W. G. S.	**William G. Smith**, B.Sc., Ph.D., Lecturer in Agricultural Botany, East of Scotland Agricultural College, Edinburgh; Translator of Tubeuf's "Diseases of Plants".
W. J. M.	**Walter J. Malden**, late Principal, Agricultural College, Uckfield; Author of "Tillage and Improvements", "Up-to-Date Farm Implements", &c.
W. S. W. St.	**William Stevenson**, B.Sc., Lecturer on Dairying in the West of Scotland Agricultural College.
W. W.	**William Watson**, A.L.S., Curator, Royal Gardens, Kew; Editor of "The Gardener's Assistant".

The classic series of articles on insects by the late John Curtis have been embodied in the work, revised by Professor F. V. Theobald and Mr. Cecil Warburton, M.A., and bear the initials of J. C. and F. V. T. or C. W.

In like manner the great botanical articles of the late Professor John Lindley, which, like Curtis's articles above mentioned, were contributed to Morton's *Cyclopedia of Agriculture*, have, under Professor A. N. M'Alpine's revision, been embodied over the initials J. L. and A. N. M'A.

THE STANDARD CYCLOPEDIA OF MODERN AGRICULTURE

Broadcast Sowing.—The common use of the drill and mechanical broadcaster (see above art.) has rendered hand-seeding of far less importance to the farmer than it was a century or less ago. Drill husbandry, which places the corn and roots in rows suitable for the operations of hoeing to be performed, and thus tends to cleaner farming, is preferred in the chief agricultural districts; while broadcasting machines distribute the seed with a regularity which cannot be exceeded by the hand-sower, and very often is not approached. There are, however, instances where hand-sowing is to be preferred to mechanical distribution; as, for instance, on land to be seeded with wheat, when the seed bed is wet below the immediate surface but dry enough on the top to allow the seed being well covered in. In such a case the fewer horses trampling the land the better, because each footprint may form an impervious dish which will hold up water, and if rain falls before the wheat has germinated it will cause the kernel to burst and growth to be impossible. This is one of the most common causes of a weak (sparse) plant or braird, and therefore of an unsatisfactory crop. Other illustrations could be quoted, but this is sufficient to show that the practice of hand-sowing should not be allowed to die out. The small holder whose capital is limited, and to whom the purchase of expensive machinery is prohibited, has frequently to depend upon hand-sowing.

Hand-sowing is an art which all men do not acquire readily, and men with thick, short hands capable of holding but little grain rarely make good seedsmen, as they are liable to let the seed fall from the hand without proper distribution. A man should also be able to give a free swing of the arm. The quantity of seed sown per acre is regulated by the length of the stride, the width of the cast, and the quantity taken up at each handful. The sacks of seed should be set out conveniently for refilling the seed basket (seed scuttle, trug, seed lip, sowing sheet, &c., as the local custom dictates), which is suspended by a strap from the neck, hanging conveniently, and not too low in front of the man. In single-hand sowing, the sower takes up a handful, and with the swing of the body in walking brings the right arm forward with the right leg. No seed should be allowed to drop until the hand is brought back ready for the forward delivery swing; then gradually opening the thumb and finger, and then the fingers, as the hand makes a semicircular sweep, should relax and open, so that the corn is strained and broken and does not fall in a too narrow strip, otherwise it will fall in rainbow ribs, forming corrugations of too thick and too thin sowing. The breaking is more effective when the corn is made to take an upward swing; against the wind it naturally breaks better than down wind. Care must be taken that there is no overlapping, and no failing to join each lap or width. Many seedsmen sow the land twice so as to get more even distribution; while a two-hand sower, by taking alternately a left and a right cast, avoids this necessity. Side winds must be regarded, and the sower walk nearer to the wind side in accordance with their strength.

Hand-sowing is convenient when sowing small seeds, such as carrots, onions, &c., where a very small quantity is put on an acre, and where the total quantity might be little more than would be required to cover the bottom of the seed box of a drill or distributor. These seeds are generally sown from the thumb and finger, the hand being kept very low, and making a narrow sweep.

In recent years a small mechanical hand broadcaster has attained some popularity, and has considerable merit, many of the little failings by hand-sowers being avoided. The main principle is an adaptation of the revolving distributor employed on some horse distributors, but a reciprocatory motion is obtained by imparting a fiddle stroke to a bow or rod actuating the throwing wheel. The spindle carrying the wheel is attached to this rod by a thong, which winds and unwinds itself as the rod is thrust forward and withdrawn, one end winding as the other is unwound. The quick motion thus obtained throws the seed, which is fed on to the wheel through a regulated feed hopper attached to the corn bag, which is suspended from the right shoulder and carried under the left arm. This little machine will throw wheat with considerable regularity as wide as 30 ft., the quickness and length of the stroke controlling the width, though in practice it is wiser not to take the full throw, especially in a strong wind.

Broadcasting involves a considerable amount of harrowing to cover in the seed, unless the land lies ribbed from ploughing or from preparation by a ring roller or furrow press. The

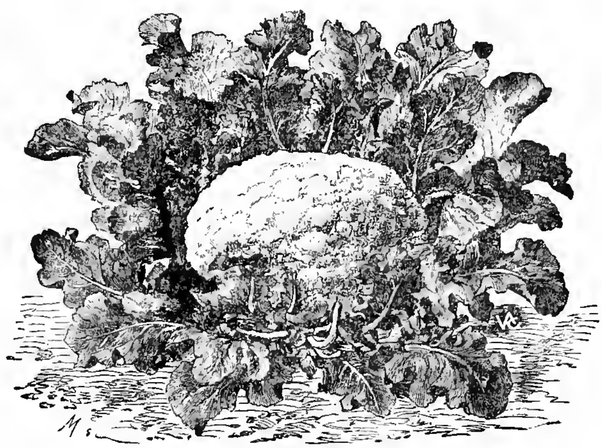
furrow press makes the best preparation for corn; and a Cambridge roller for small seeds, such as clovers or grasses, as a definite depth of covering is thus secured. However, if the ground lies loose, it may not be necessary to do more than let these seeds fall on the surface and then harrow them in, because they require very slight covering.

Broadcasting manures by hand is rarely satisfactory, especially where small quantities are sown per acre. The first essential in sowing manures is even distribution, and powdery manures do not sow evenly, as the varying size of the particles causes them to be thrown irregular distances. Distributors depending upon wind force to cast the manure are unsatisfactory, because the irregular pace of horses produces irregularity in the width of the throw. Horse-driven machines which depend on the throw from horizontal disks are subject to similar irregularity. There has been great improvement in manure distributors in recent years. Both corn and manure distributors are made with a variety of 'feeds', or methods of abstracting a regular and continuous flow from the bulk contained in the hopper. See art. BROADCAST MANURE DISTRIBUTION.

[W. J. M.]

Broad-leaved Trees.—The term 'broad-leaved' is used in European forestry to distinguish those trees that belong to various genera of dicotyledonous angiosperms from trees belonging to coniferous genera or gymnosperms. The leaves of the former belong to the ordinary type, in which the blade is widened out to a thin membranous tissue, the upper portion of which is composed of 'palisade tissue', the under portion of 'spongy parenchyma', in which are embedded the vascular bundles or 'veins', forming a network over the under surface of the leaf. The wood of broad-leaved trees is distinguished from that of conifers by the existence of true vessels and libriform fibres, in addition to the wood fibres, tracheides, and medullary rays which make up the bulk of coniferous wood. The principal broad-leaved trees indigenous to or naturalized in the British Isles are the following: Oak, ash, beech, elm, hornbeam, Spanish chestnut, sycamore, &c., which are known as 'hard woods', and alder, birch, lime, poplar, willow, &c., known as 'soft woods'. In the British climate, all of the above are deciduous, or lose their leaves during the winter months; but in the south of Europe several species of oaks are evergreen, while the holly is an example of an indigenous evergreen broad-leaved tree. In sylviculture, broad-leaved trees are usually confined to the better soils and lower elevations of the valleys and plains, although birch, poplar, willow, and alder are capable of thriving on poor soils at high elevations. [A. C. F.]

Broccoli.—Broccoli is a winter form of the cauliflower, both of them being varieties of the cabbage (*Brassica oleracea*). The Broccoli is hardier and larger than the cauliflower, and its leaves are stiffer and more distinctly stalked. It is grown for a supply of cauliflower-like heads in spring. It therefore takes longer to come to maturity than the cauliflower, which is essentially a summer vegetable. The seeds are sown about the middle of May, and the plants are usually transplanted once before being finally placed where they are to develop. From the first the Broccoli requires a good, well-manured soil. The London growers—and there are hundreds of acres of Broccoli grown for the London market—sow the seeds in drills 6 in. apart, transplant the seedlings into beds in a sunny position, setting them about 4 in. apart, so that when they are again lifted they can be taken up with a good ball of soil attached to the roots.



Broccoli—Bath White

The soil should be well firmed about the plants, as loose ground induces leggy, sappy growth. The hardiest Broccoli are grown on land which has borne a crop of early Peas or Strawberries, the soil being merely cleared of weeds, &c., and loosened on the surface before the Broccoli are planted. They require plenty of room, $2\frac{1}{2}$ ft. each way being none too much for the larger sorts, and 18 in. to 2 ft. for the smallest. If properly handled from the start, Broccoli soon extend their roots deep down into the soil, and are therefore less likely to injury from drought than if their roots were on the surface. A severe frost may spoil most of the crop; generally, however, Broccoli goes through the winter uninjured. The heads should be cut whilst they are solid, and not left until they have become separated. The best varieties are the following:—

Late Green; very hardy; fit for use in April and May. *Bath White*; grown to succeed cauliflowers, being ready to cut in November and December. *Frogmore*; a hardy, white-headed sort, one of the best of the later kinds. *Latest of All* protects itself by means of its infolding leaves; it is usually at its best in May. *Snow's Winter White* has large heads, and is ready

for use in December. *Sprouting* is remarkable for its second growth of lateral heads after the terminal one has been cut. *Veitch's Autumn* has firm, compact white heads of delicious flavour, and is perhaps the best early variety; it should be raised from seeds sown under glass in March. [W. W.]

Brock. See Badger.

Broken Knees.—The term 'broken knee', as understood by horsemen, seldom includes the fracture of any bone or bones, but is applied to an injury on the front of the knee which leaves a blemish of greater or less extent when healed. Such blemishes are of relatively little importance in other animals than the horse, but seriously depreciate his value without necessarily impairing his usefulness. A blemished or broken knee is not an unsoundness, although its presence calls for remark in a veterinary surgeon's certificate. The extent of the injury is not always to be determined by the size of the scar, and experience has taught horse owners that an animal that has once fallen and injured the skin over the knee, is more liable to suffer from a repetition of the accident than one which has never 'been down', as it is called. Defective conformation may have caused the horse to fall, or, in the healing process, some loss of mobility may follow on the binding down which supervenes on the formation of cicatricial tissue. Often enough no injury beyond the skin results from a fall; on the other hand, fatal consequences may follow on the escape of joint oil, when the capsule is broken or gives way as a result of subsequent inflammation and sloughing of adjacent structures.

Treatment.—Cleansing of the wound with an antiseptic (see Antiseptics and Disinfectants) should be the first step, and if the accident occurs at any distance from succour, the animal had better be walked home without any interference with the wound, rather than that the proffered dirty sponge and water to be found at most wayside stables should be used. Bathing with warm water may be necessary to remove grit and foreign bodies, which should be looked for at the time. The animal should be slung, or otherwise prevented from lying down, while a poultice with carbolic acid or other antiseptic substance is applied. Charcoal in powder mixed with linseed meal, or bread and glycerine, turnips boiled, or other moisture-holding materials, in a muslin or old calico wrapper, should then be placed over the wound, but not hotter than the naked elbow can comfortably bear. About two days of poulticing will usually suffice to form matter in which grit will come away. Behind the discharge of pus, red granulations begin to form, and are intended to fill up the space. At this stage the amateur doctor commonly fails, and may be warned to avoid poulticing or fomenting if he would have a level wound, and not be hampered by those profuse granulations which are still spoken of as 'proud flesh'. In order to keep any poultice or bandage on the knee, a foundation must be built up of tow or other material, below the joint, or it will assuredly slip down and do injury. A light covering bandage, steeped in a 4-per-cent carbolic lotion, will be a suitable application for two or three days following the poulticing, and then the wound may be exposed to the air. In many bad cases the granular tissue grows too fast in one place and not enough in others, and here the experienced surgeon is needed. He will discourage the prominent points by touching them with a solid nitrate-of-silver pencil, while dusting the little depressions with powdered resin or other stimulants, and his treatment will from this stage be aimed at getting a dry, hard scab quite level in appearance. More than this, he will seek to minimize the final blemish by roughly breaking off the scab every day or two and cauterizing the raw surface with his nitrate-of-silver or lunar-caustic pencil, as this results in a smaller scab each time and a drawing together of the skin, of which there is plenty to spare beyond the wound. The elasticity of skin is thus utilized to pull it over the injured part, when there will finally be no greater disfigurement than the actual scar must cause. The 'bumpy' and enlarged knees to be seen on the roads are due to neglect of these precautions. Full-blooded or gross horses, or such as have a tendency to grease, should have a full dose of aloes at the commencement of the treatment, and laxative foods should be given throughout, as it is not desirable to exercise the patient until the first inflammatory process has given way to scabbing over. Even then some practitioners object, on the ground that tetanus (lockjaw) is more likely to supervene. Bandaging with gentle pressure from the foot upwards, and a dose or two of nitre, will help to fine the legs, which are naturally disposed to swell during enforced standing for a lengthened period. The temptation to cut away ragged portions of skin must be resisted, the good surgeon retaining every atom unless or until it is clearly seen to be dead or sloughing, when it should only be gently pulled away, and not cut. We have here supposed only such ordinary cases of broken knee as the horse-owner is called upon to treat himself, but there are serious cases which should be entrusted to the veterinary surgeon. Deep-seated bruises or even fractures may be discovered, the knee breaking out at the back and fistulous wounds being established. When the synovia or joint oil escapes, the case becomes very serious, and many horses have to be destroyed on that account. If successfully treated there will probably be permanent stiffness remaining. See Open Joint. [H. L.]

Broken Wind, a term used to indicate a condition in the horse where there is loss of expiratory power of the lungs. The direct cause is increase of pressure in the air vesicles, brought on by cough, &c. The condition is regarded as hereditary. Feeding on damaged hay or straw, too bulky and innutritious food, and keeping the horse in a dusty atmosphere tend to produce a cough, and so bring about or predispose to broken wind or 'heaves'.

Symptoms.—In the process of breathing, air is taken into the lungs in a natural manner, but is expelled from them by two distinct efforts, the muscles of the abdomen aiding in a marked manner in the final act of expiration; this is

apparent by the heaving of the flanks. There is a peculiar cough, which is short and something like a grunt. The difficulty in breathing is constant, but varies in intensity, being greatest after the horse is fed. The digestion and general health of an animal suffering from this disease are usually much out of order. The abdomen may assume a form known as 'pot-bellied'. The animal frequently passes wind of an offensive odour, and the bowels are often very loose when the animal is worked.

Treatment. — When the disease is established there is no cure for it, but palliative treatment may be adopted. Feed and water the horse by small quantities at a time. Clover hay or bulky food should be entirely omitted. The diet should be confined to food of the best quality and in the smallest quantity, and the animal should be invariably watered before feeding. The animal should not be worked immediately after a meal. Carrots, potatoes, or turnips, chopped and mixed with oats, are a good food. Medicinally, give half an ounce of Fowler's solution of arsenic in the drinking water twice a day, and this quantity may be cautiously increased as the animal becomes accustomed to the drug. If the bowels do not act regularly, a pint of raw linseed oil may be given once or twice a month. It must be remembered, however, that all medical treatment is of secondary consideration; careful attention paid to the diet is of greatest importance. [H. L.]

Soft Brome Grass (*Bromus mollis*)

Brome Grasses.—There are many species of Brome grasses belonging to the genus Bromus. They are harsh or hairy grasses, more important as weeds than as forage. The sheath of a Brome grass leaf is very characteristic—for it is entire and not split, as is usually the case with other grasses. Three Bromes have been recommended for cultivation: (1) Awnless Brome, or Hungarian Forage Grass (*Bromus inermis*, Leyss.); (2) Schrader's Brome Grass (*Bromus Schraderi*, Kunth); (3) Upright Brome (*Bromus erectus*).

1. Awnless Brome is a perennial grass, creeping extensively underground, which has been recommended for poor light soils; but in this country it has not proved a success, although in Hungary, on dry soils, it gives a large yield and is extensively cultivated.

2. Schrader's Brome.—This is a perennial forage grass which was introduced into this country by the Messrs. Lawson of Edinburgh in 1842. Experimental trials have shown that the grass is of little use for us, as the herbage is too coarse, and as the plant is very liable to be killed off in winter. The ears of this Brome are very handsome; they are often dyed, and sold in bunches for ornamental purposes.

3. Upright Brome.—This is a hairy perennial species, distinguished from other Bromes by the young leaves being folded and not rolled up. On chalky soils on the Continent it is grown along with Sainfoin or Lucerne. Stebler in his Best Forage Plants gives a full account of this species.

Two Brome grasses important as weeds may be briefly considered:—

(*a*) Soft Brome (*Bromus mollis*, L.).—This is a very common hairy annual or biennial weed, with thin harsh foliage and a narrow raceme of erect spikelets, some of the lower arms of which are occasionally branched. It grows abundantly by roadsides, and in dry waste places, where cattle leave it if any other food can be found. It is in ear in June, and ripens in a fortnight; if cut down at that time, it again ears and ripens in a much dwarfer state. It can be regarded only as a troublesome weed, which the farmer should take care to extirpate, for it seriously diminishes the quantity of his hay, as well as deteriorates its quality. Like all annuals, it may be destroyed by constant mowing, or by feeding down so as to prevent seeding.

(*b*) Field Brome (*Bromus arvensis*, L.).—This is another hairy annual weed, growing about 3 ft. high, with a drooping panicle of spikelets, which are bald, and not hairy as in Soft Brome. Each spikelet produces about eight 'seeds'. Field Brome is found in fields, and is more common in the North than in England.

[J. L.]
[A. N. M'A.]

Bronchitis. — Bronchitis is an inflammation of the bronchial tubes—the tubes that ramify through the lungs as a continuation of the windpipe. When this inflammation extends to the air sacs at the termini of the smallest branches of the bronchial tubes, the disease is called broncho-pneumonia. Bronchitis affecting the larger tubes is less serious than when the smaller are involved. The disease may be either acute or chronic. The special causes of bronchitis are: the inhalation of irritating gases and smoke, the fluids and solids gaining access to the parts. Bronchitis is occasionally associated with influenza and other specific fevers. It also supervenes on sore throat.

Symptoms of Acute Bronchitis.—The animal

appears dull; the appetite is partially or wholly lost; the head hangs; the breathing is quickened; a cough, at first dry, is succeeded in a few days by a moist, rattling cough; the mouth is hot; the visible mucous membranes are red; the pulse is frequent. There is a discharge from the nose which varies in colour from a white to a brownish red. If in serious cases all the symptoms become aggravated, the breathing is laboured, short, and quick, it usually indicates that the inflammation has reached the breathing cells and that catarrhal pneumonia is established.

Bronchitis affecting the smaller tubes is more often than not fatal, while that of the larger tubes is never very serious.

Treatment.—The matter of first importance is to ensure a pure atmosphere to breathe, and next to make the patient's quarters as comfortable as possible. Keep the animal well clothed as the season of the year demands. Rub in some mustard paste well over the side of the chest, covering the space beginning immediately behind the shoulder blade and running back to about the 9th or 10th rib. Steaming should be resorted to, and the steam should be impregnated with some suitable antiseptic, such as eucalyptus oil, turpentine, friar's balsam, or spirits of camphor. In serious cases the steam should be inhaled every hour, and in any case the oftener it is done the greater will be the beneficial results. If the animal has lost his appetite, he ought to have a dose of Easton's syrup occasionally. If the bowels are constipated, enemata of warm water may be given. Do not give purgative medicines. A soft laxative diet is preferable. Good nursing and patience are required. When the symptoms have abated, and nothing remains of the disease except a cough and a white discharge from the nostrils, all other medicines should be discontinued, and a course of tonic treatment pursued. Give to the horse or cow the following mixture: Reduced iron, 3 oz.; powdered gentian, 8 oz.; mix well together, and divide into sixteen powders. Give one powder every night and morning mixed with bran, or shaken up with flaxseed tea and administered as a drench. Give to the dog 5 or 10 drops of Easton's syrup according to his size and age, three times a day.

Symptoms of Chronic Bronchitis.—An acute bronchitis may become chronic. It is, however, in the main a disease of old age. It frequently occurs in the ox, and there is in these cases a persistent hacking cough, general weakness, a tendency to slight febrile attacks, wasting, and inability to undergo exertion. This disorder may be associated with asthma, broken wind, and consolidation of lung. In many cases, though tonics, quiet, and easily digestible food will do a great deal of good, slaughter is the best course. For an account of parasitic bronchitis see Hoose. [H. L.]

Broncho or **Bronco,** a name given to the native horse or Indian pony of the western American States, and applied more or less to the half-broken animals used by cowboys and ranchers. In South America, bronchos are small active horses, and derive their name from a Spanish word (*bronco*) meaning untrainable, or not to be properly broken. [H. L.]

Brood Mare.—The selection of the brood mare is a point of the utmost importance, and if success is to attend the efforts of the stock-breeder, the greatest care must be exercised. It is no economy to breed from cheap, underbred mares, as the expense of feeding and maintaining such animals is as great as in the case of valuable pedigreed stock, whose progeny in the future course of events command a much higher figure when put on the market.

The conformation of the brood mare should be on general lines similar to that of the male animal of the same breed, although she is usually smaller and finer and lighter over the head and fore quarters; but whereas length of back is undesirable in the male, it is found that roomy, lengthy-bodied mares with strong loins and broad hips prove the most successful breeders; this conformation being natural to allow of the accommodation of the fœtus in the womb, and the broad pelvis facilitating the act of parturition.

Some mares, and usually those of good type with a long pedigree, possess the inestimable virtue of *prepotency*, or the power to breed true to themselves; and no matter what stallion they are mated with, the resulting progeny resemble their dam. A mare of this type cannot be too highly prized, as has been proved time and again; and it is owing to this gift of prepotency that the names of many mares and stallions have become household words.

The age at which a mare should be put to the stud is a question around which much controversy has gathered among breeders of horses. The common practice of breeding from two-year-old fillies, unless the animal is exceptionally strong and well-developed, is open to severe criticism; for there can be no doubt that to impose upon a mare the task of reproduction while actively engaged in building up her own frame, and to ask her subsequently to support her offspring, is very probably a certain means of restricting her own growth, if it does not enfeeble her constitution.

The chief reason why this practice is so prevalent is that between two and three years of age the mare is rarely working, and if she can produce a foal in the meantime this should go so far towards paying for her upkeep. Provided this practice is adopted, it is absolutely imperative that during the period of pregnancy, and while suckling her foal, the youthful mother should have the most liberal and nutritious diet, otherwise the strain will be too excessive.

We are aware that many examples of prize stock bred from three-year-old mares exist, but their proportion is small, and not sufficient to encourage the adoption of early breeding as a general system. It is to the interest of the race and the breeder alike that mares should not be put to the stud before three or probably four years old, when their growth being nearly completed and their generative organs developed, their physiological energy can be devoted to the function of maturing the fœtus.

The opposite practice of breeding from some

aged favourite mare when she is unable for further work is also to be condemned, as often these animals are extremely difficult to impregnate, and if they have not been breeding in early life their generative organs are to a certain extent undeveloped, their vitality is impaired, and their progeny are often small and disappointing.

The one fundamental principle of breeding is that 'like produces like', but in its practical application the breeder must make certain reservations, which are the result of long experience. One of the most important of these reservations is that although well-bred animals of long and good pedigree can be depended on with great certainty to reproduce their like, the same cannot be said of animals which have not the advantage of this long and careful breeding.

This explains why representatives of a newly formed breed, or 'chance' animals, however good in themselves, so frequently fail to reproduce their type—they are quite likely to throw back to some ancestor of quite a different type. It may be taken as a general rule that the longer and more carefully any class of animal has been bred, the greater will be its prepotency, or certainty to reproduce its type, and that pedigree is a most important point for consideration in the selection of breeding stock. It is never safe to mate animals of widely different types, in the hope of striking the happy medium between the two parents in the offspring. It is probable the result will be a bad representative of one type or the other, or a throw back to a remote ancestor of quite a different type; therefore, if it is desired to modify an existing type, the process must be a gradual one.

The care and management of the pregnant mare is an important branch of stud management, and to error in this matter is referable a certain percentage of sickness and mortality of a common and preventable nature. Overfeeding and overfattening for show purposes is accountable for the low proportion of foals which our famous prize mares produce, the state of obesity being entirely opposed to successful procreation.

Good health is unquestionably the body condition most conducive to productiveness in the dam and growth in the young; and this state can only be acquired and maintained by a judicious system of liberal feeding and suitable work. The former should be within the reach of all, but unfortunately, for obvious reasons, the latter cannot always be adopted, consequently many brood mares live a life of idleness, and in their case the greatest care should be taken that they get daily, healthy exercise, especially in the later months of pregnancy.

It is generally conceded that nothing conduces so much to the production of strong, healthy offspring as giving the mare a reasonable amount of work under judicious management. It is common enough for mares to work right up to their date of foaling, and especially among small farmers who depend for their livelihood on the labours of their mares. If care is exercised, they should with safety work up to at least a month of their time. These pregnant mares, however, should be guarded against severe exertion, such as drawing heavy loads in deep ground or hilly roads, or backing, or trotting at a fast pace (in the case of the lighter breeds), nor should they undergo long fasts or suffer fatigue.

The method of wintering idle brood mares varies, depending on the climate. In some parts of England, and the south of Scotland they are allowed to lie out at nights, or open sheds are afforded to protect them from the inclemency of the weather; but the more common method of housing them at night in a loose box is to be preferred, because the extreme cold and often wet nights tend to lower the vitality, and may even produce abortion, or at least retard the development of the fœtus, and is not economical, as more nutritious food is necessary to maintain the body temperature.

As a rule, the end of April is quite soon enough for the birth of the foal, but of course this depends on the climate of the district. The grass by this time should be in evidence, and this is the natural and best food for the mare when suckling; but in these days of horse shows and costly prizes, great temptation is offered to the breeder of pedigreed stock to strive after early product, and resort to a system of forcing which, while productive of a limited and temporary success, cannot be otherwise than detrimental to the general wellbeing of the horse.

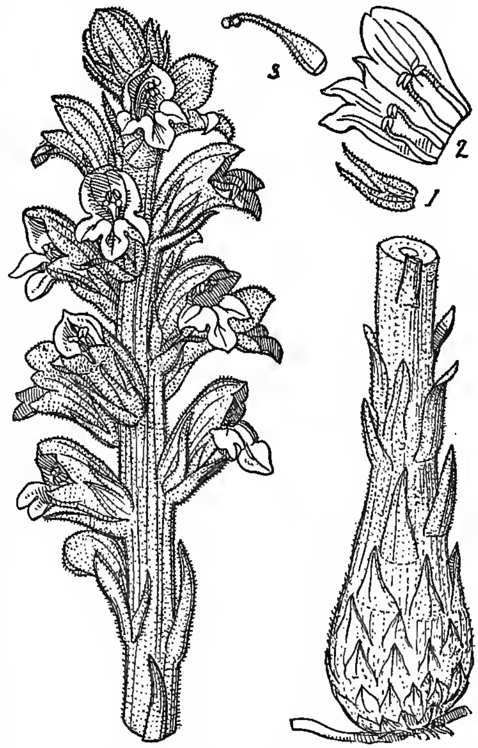
Late foals miss the early succulent grass which is so productive of a copious milk supply, and are seriously handicapped, and further the nights are becoming colder, and the youngster will be shedding its coat at a time when it should possess its winter garment; all this tending to lower its vitality and check growth. If foals are to make good horses they must bask in the sunshine of summer, and receive an abundant supply of rich milk and ripe herbage it affords. See arts. ATAVISM, BARRENNESS, BREEDING, PRINCIPLES AND LAWS OF; HEREDITY, TELEOGNY, &c. [J. R. M'C.]

Brood Sow.—Generally speaking, pig-breeders appear to take even less care in the selection of their breeding sows than in the choice of the boars which they purpose entering into their herds. A not unusual argument heard is that with a really good pure-bred sire it matters little as to the sow, since the former is bound to correct any weaknesses possessed by the dam. Just why the first sow coming to hand, and one evidently far from perfect, should necessarily be taken does not appear on the surface. It must be more profitable to select a brood sow light in the fore quarters, long and deep in the body, with hind quarters long and wide, and possessing at least twelve teats or paps of the same size, equidistant one from the other and commencing from a point as near the fore legs as possible, than a nondescript of doubtful temper, prolificacy, or milking qualities. The two last-mentioned qualities are frequently wanting in the most fashionably bred pigs, and in those which have no breeding and have had no care and attention paid to their good points. The fashionable pigs are unfortunately often

bred solely for their aptitude to fatten, or some fancy points which have little or no commercial value. The rule that the boar should be neat and compact does not apply to nearly as great an extent to the brood sow—indeed some of the best breeding sows have been large and somewhat loosely made. Sows of this form appear to be more prolific, better sucklers, and more careful with their little pigs. It is also an advantage when a sow is suckling a large litter of pigs that she should be long in the body, so that when the pigs become five or six weeks old they may still have sufficient room to enable them to get at the special teat, without crowding and quarrelling with their neighbours. When selecting a young sow for breeding purposes care should be taken in the examination of the udder, as frequently the teats are unevenly placed; they also may vary in size and are sometimes blind. These last are useless to the youngsters; whilst the young pig which is unlucky enough to select the undersized teat for its own is sometimes starved to death, or if it escapes this sad fate it is arrested in its growth and becomes what is termed in different parts of the country a wrackling, dilling, pitman, &c. It may be asked, why should this be, since each young pig has an equal opportunity of seizing upon and converting to its own special use the lacteal supplies of the common dam. This, like so very many theoretical views concerning stock-breeding and management, does not work out well in practice, for the simple reason that nature does not work by theoretical, but by common-sense and practical rules. If, as the theorist imagines, each little pig had an equal chance during its babyhood of partaking of a defined proportion of its mother's milk, it could only be obtained by continual warfare amongst the piglings to secure and retain the best teat; this would mean extreme family discord, and most probably permanent damage to the udder of the sow. To prevent this, nature decided that each little pig should in very early life select its own particular teat and stick to it. [S. S.]

Broom (*Sarothamnus scoparius*) is a glabrous shrub of 3 to 5 ft. high, with numerous long, straight, erect, wiry, prominently angled, and almost glabrous branches. The lower leaves are shortly stalked, with three small, obovate leaflets, the upper leaves being sessile, and the leaflets often reduced to a single one. The large, bright-yellow flowers are solitary or in pairs on slender pedicels in the axils of the old leaves, and form handsome leafy racemes along the upper branches. It is closely allied to the genera Genista, Cytisus, and Spartium of the sub-order Papilionaceæ (nat. ord. Leguminosæ), and is common throughout Britain on dry, hilly wastes and bushy places, where it flowers profusely in spring and early summer. Wherever broom (or also furze) occurs, the land is almost sure to be suitable for timber-planting, as it is generally loamy and well drained. But as the lofty spreading growth of Broom is dangerous to young trees, it should, before planting, be cut over with the switch-bill in June or July, after the flowering, but before the ripening of the seedpods, and then burned in late summer or early autumn to kill it outright, or check its growth until the young crop planted in the following spring outgrows the danger of being overgrown and interfered with. This will usually suffice for ordinary young Broom; but if the growth of old Broom be so strong as to necessitate grubbing up by the roots, then this should be done in 4 ft. strips along the lines to be planted, and the rubbish burned when dry enough. [J. N.]

Broom-rape, including **Clover-rape** (*Orobanche*).—This plant is destitute of green



Broom-rape (*Orobanche major*)

1, Calyx segment. 2, Corolla open. 3, Ovary.

colouring matter, and so, unlike green plants, is impotent to manufacture sugar and starch from carbon dioxide and water to meet its food requirements. Under these circumstances broom-rape betakes itself to a parasitic mode of life, and becomes a robber of other plants. If it is robbing a broom it is a broom-rape; if a clover, a clover-rape, and so on. To get command of the food in the plant to be robbed, the parasite makes a special tool, called a sucker, which is inserted into the host plant—always, be it noted, into the root of the host. This peculiar mode of attack entitles these rape plants to the special name *root-parasite*. Once the robber gets command of food resources, he immediately turns them to good account, for he transforms them into a corpulent underground body called the tuber. This tuber produces branches at

the sides and a bud at the apex. The branches at the side extend out in search of prey, and if they find a suitable root they enter in and become new suckers, exploiting the clover or the broom so completely that it dies.

The next business on hand is reproduction by seed; for this, the rape has to work up the bud on the tuber into a seed-making machine. Accordingly, a fleshy, ruddy shoot projects from the underground tuber up into the air, often to a height of 2 ft. This air shoot is peculiar in two respects: it contains no green colouring matter, and it bears no foliage, but small pointed scales instead. At its end there is a spike cluster of russet, clammy, two-lipped flowers which ripen into capsule fruits. Each capsule fruit is loaded with a multitude of seeds, so fine that they look like particles of blackish dust. These minute seeds are shed from the capsules in thousands and scattered all over by the wind.

In the ground the seed germinates, producing a minute thread-like body, which is the seedling. There are here no seed-leaves as in green plants, for in the case of a seedling rape seed-leaves would be in the way rather than of use. The thread-like seedling must die from starvation unless it comes into contact with the root of a suitable host plant. Now we see the reason for producing the seeds in such extraordinary numbers. Many seedlings must come to naught, only the very few can secure means of livelihood as parasites. Should the tiny filament from the seed come into contact with a clover root, all is well; the sucker is inserted, the tuber is made, new suckers are produced from the tuber, and further clover plants attacked; finally the air shoot forms the seeds and gets plenty of them ready for scattering all around, the whole substance and power of the plant, indeed, being devoted to this seed-making business.

Roughly speaking, two species may be distinguished: (1) the Larger Rape or Broom-rape (*Orobanche major*, L.), attacking broom chiefly; and (2) the Smaller Rape or Clover-rape (*Orobanche minor*, Sutt.), attacking red clover.

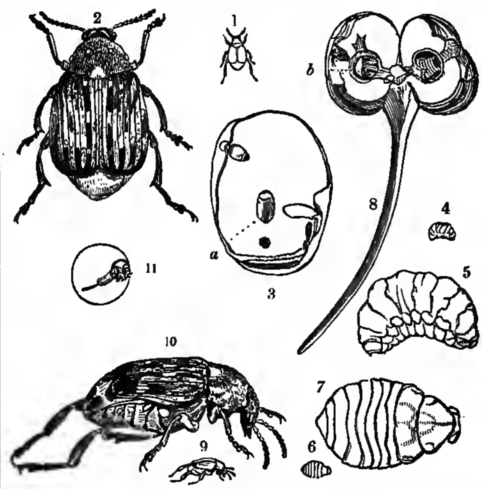
To prevent attacks of clover-rape, the seed of the red clover must be absolutely free from the seed of the parasite—that is the very first precaution to be taken. If any spot of the clover field shows signs of the presence of the parasite, the plants there should at once be dug out and burnt to prevent the seeding and spread of the rape. If the parasite has managed to establish itself on a field of clover, the clover should at once be dug up to prevent the seeding of the parasite. Some assert that it suffices to cut the clover crop early and manure with superphosphate. On no account should rape plants be allowed to seed. [A. N. M'A.]

Broom, Spanish. See SPARTIUM.

Brown Colour. See COLOUR IN ANIMALS.

Bruchus rufimanus (the Bean Grain Beetle; see accompanying figs.) is very destructive to field and garden beans and peas. The female lays her eggs when the beans are in flower; the maggots hatch and eat into the seeds, generally forming an oval cell in the interior; these maggots are yellowish-white, and when full fed they change to pupæ; and the beetle, when it hatches, eats its way through the skin of the bean. The beetle is smaller than *B. pisi* (the Pea Beetle), black, variegated with white and tawny; the base of the horns and the fore legs are tawny.

B. pisi (the Pea Beetle) is a most destructive species to the pea crops in North America and southern Europe, but in England it is only found dead in imported peas. The eggs are laid in almost every pea, where they hatch; the maggots consume all the contents, and, when transformed to beetles, they force themselves through the skin, as shown at (11). They are black, variegated with bright brown hairs; the sides of the trunk are notched, with



1, the Bean Beetle, natural size; 2, magnified; 3, bean split open, showing cell at *a*; 4, maggot, natural size; 5, magnified; 6, pupa, natural size; 7, magnified; 8, bean which has vegetated inhabited by beetle; 9, Pea Beetle, natural size; 10, magnified; 11, beetle inside of pea.

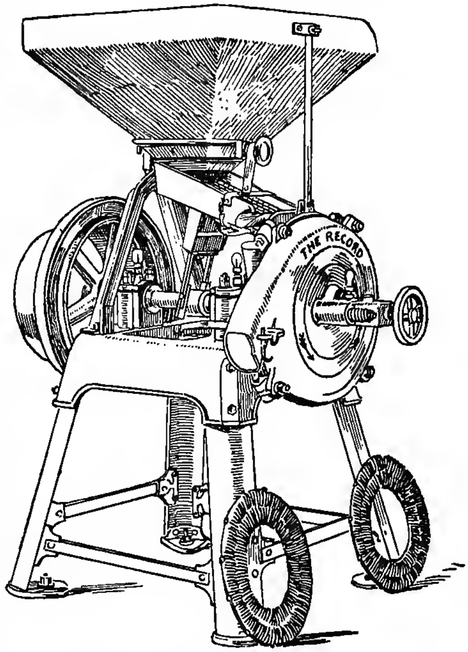
a whitish spot at the base; there are two white dots on the disk of the wing cases, and an irregular line of white dots; the rump is whitish, with four large black spots; four basal joints of the horns and fore legs bright tawny; hinder thighs toothed.

Prevention.—It is important to avoid sowing infested beans and peas. Seeds with holes in them show that the beetles have emerged, and therefore they are safe as regards future attack, though their germinating power may be impaired. Where the beetle is still in the seed, its presence may be detected by the round depression where the skin alone covers the hole by which the beetle makes its exit, and a sample of beans it is proposed to sow should be examined for this indication, and rejected if infested by the pest. If beans are kept over till the following year, they may be sown with safety, as the beetles will either have emerged or died in the seeds. Or the beetles may be killed by subjecting them to the vapour of carbon bisulphide in a closed bin, but with due caution, for the fumes are poisonous and inflammable. The fluid is sprinkled on the top of the beans and

the lid tightly closed down. No light must be brought near till the lid has been opened some time and the smell has passed away. [J. C.]
[C. W.]

Bruiser, Corn.—The practice of bruising, cracking, or 'grittling' corn is now general, and it is safe to say that the farmer is remunerated for the expense he incurs, as the food is rendered far more easy of digestion, consequently great value is derived from it. Farm mills are of several types, and are made adjustable, so that a bean may be cracked or reduced to a fine flour, or be broken to any intermediate size. Where chaff is fed with grain it is well to reduce the grain to a fine meal, as then it so intermixes with the chaff that animals cannot eat it without also eating the chaff. It is not so suitable for being fed from troughs out-of-doors without chaff, as wind is likely to blow it away or rain to run it to a paste. There are many forms of mills, and an American machinist has divided them into thirty-five types; however, it is ordinarily accepted that there are six types. (1) Stone mills; (2) metal disk mills placed vertically; (3) conoidal metal disks; (4) grooved roller and breast; (5) conical roller and breast; (6) roller mills. In the trials of the Royal Agricultural Society at Plymouth the superiority of the metal disk mill was clearly demonstrated; while one with a metal roller and breast, and another with a conical metal roller and breast, did good work of about equal merit respectively. The results from other types were not sufficiently good to warrant their preference over either of the three types mentioned.

In deciding the awards the judges kept in view the fact that they were judging for farmer's ordinary grist purposes. For instance, the millstones did good grinding work in producing fine meal, but not such good grist work, falling short in adaptability to cope with the different kinds of grain used on the farm. As these trials were so thorough, the table of



Nicholson's Fluted-disk Corn Bruiser and Grinder

Disks are shown supported against the frame. In work the disk is on the main spindle.

work accomplished by machines representing the several systems is appended:—

System.	Material.	Quantity of material.	Time occupied.	Total units of power consumed.	Units of power required per cwt.	Quantity of material per hour.	Mean horse-power.
		lb.	minutes.			lb.	
	Maize		2·33	562,120	1,124,240	1442	7·31
Flat metal disks	Oats	56	3·66	480,197	960,394	918	3·97
	Barley		3·27	495,321	990,642	1027	4·59
	Maize		2·13	482,718	965,436	1577	6·86
Metal roller and breast	Oats	56	2·0	265,936	531,872	1680	4·03
	Barley		3·47	603,712	1,207,424	968	5·27
	Maize		3·28	1,203,644	2,407,288	1024	11·12
Conical metal roller and breast	Oats	56	3·65	472,635	945,270	920	3·92
	Barley		4·58	1,380,094	2,760,188	733	9·13
	Maize		4·25	714,624	1,429,248	790	5·09
Conoidal disks	Oats	56	3·05	507,925	1,015,850	1101	5·04
	Barley		3·33	1,025,933	2,051,866	1009	9·30
	Maize		6·75	1,638,468	3,276,936	497	7·35
Stone	Oats	56	4·53	733,529	1,467,058	741	4·90
	Barley		6·58	1,618,302	3,236,604	510	7·45

The general use now of rollers for milling fine flour might suggest that roller mills should make the best grist mills, but this is not the case, although they are excellently adapted to crush oats, and are largely used for this purpose. [W. J. M.]

Bruises. — Bruises are contused wounds where the skin has not been ruptured. They may result in local death, and sloughing of the bruised parts. If the bruise is not so severe, many cases are quickly cured by constant fomentation with hot water for from two to four hours.

Cold fomentations must then be kept up for another hour or two; the parts thoroughly and quickly dried, and bathed freely with Goulard's solution. A dry, light bandage should then be applied, and the animal allowed to rest, and, if necessary, the treatment may be repeated for two or three days. If, however, sloughing must ensue, the part ought to be poulticed with linseed meal or wheat bran to encourage the slough; charcoal or salt ought to be sprinkled over the poultice when the wound is bad smelling. After the slough has fallen off, the wound is to be dressed with warm antiseptic washes of carbolic acid, lysol, or chinosol. Besides this local treatment, one must control the constitutional symptoms of fever and inflammation. This is best done by placing the animal on soft food. A physic ball of 4 or 5 dr. of Barbados aloes should be given as soon as possible after the accident, if the injured animal is a horse, and 1 lb. of Epsom salts to cattle.

Sedatives may also be administered when the symptoms of fever are abated, and if the discharges from the wound are abundant, the strength of the patient must be supported by good food and tonics. One of the best tonics is as follows: Powdered sulphate of iron, powdered gentian, and powdered ginger, of each 4 oz. Mix well, and give one tablespoonful to a horse, and two tablespoonfuls to a cow, twice a day on the food made damp, or as a drench.

[H. L.]

Brush Drains. See DRAINAGE.

Brushes.—The brushes commonly used on the farm are: (1) whalebone, (2) bass, (3) birch broom or besom, (4) water brush, (5) dandy brush, (6) spoke brush. The whalebone is well suited to barn work, for sweeping courtyards, cow byres, &c., and for sweeping seed on threshing cloths, as in turnip-seed threshing, and the bass may be used for similar purposes. The birch broom is a cheap sweeper, more especially where a wide sweep can be taken, and where much resistance is not met, though as it gets worn and stiff it makes a good yard brush in wet and dirty places. The water brush is used for cleaning dirt from horses' legs and feet. The dandy brush is somewhat softer, and is used for grooming the skin of the horse; it is to this that the 'elbow grease', or hard and frequent work which gives a good coat to horses, is applied. Sore shoulders, sore withers, and sores wherever the harness fits to a horse are very much the result of the want of more brushing to keep the skin clean. [W. J. M.]

Brushing, Interfering, or **Cutting** is a peculiarity of some horses, caused by hitting the inside of the leg with some part of the foot or shoe of the opposite limb. It occurs in all sorts of horses, but is commonest in well-bred ones and the lighter breeds. It is largely due to bad conformation, but is also influenced by the state of 'fitness' the particular animal is in, by its age, and the shoeing.

It may be symmetrical, that is, occurring on both legs and at the same place on each, or one only may be affected. It occurs both in front and behind, but of the two, brushing in front is the more serious. The part affected also varies, the commonest spot is perhaps the fetlock joint rather towards the back; it may occur on the cannon bone, even as far up as directly under the knee, when it is known by the name of 'speedy cut'.

Brushing is very often seen in young horses just up from grass, appearing shortly after they are put to work, and when that work is somewhat too severe. It may begin by a bruising merely of the opposite joint, occurring only now and then. The joint becomes inflamed and swells. Next day the horse is taken out before the swelling has had time to go properly down, and the same thing occurs again, and so on until the joint or joints become permanently enlarged. The increase of size naturally aggravates the trouble, by the larger area exposed to injury, and the narrowing of the distance between the joints, which increases the liability of being struck by the opposite foot or shoe.

The exact spot of contact depends a good deal on the horse's gait, the size of his feet, method of shoeing, and irregular action of the joints. If there is high action, and a tendency to dishing outwards, we may expect to see a 'speedy cut', or the mark high up on the leg. If, on the contrary, he travels close to the ground, only raising the feet sufficiently to barely clear the ground, the coronet, or wall of the hoof itself, will probably be the part affected. When there is bruising only, the joint is most likely to be struck by some part of the hoof; but if there is a wound, then the edge of the shoe is probably responsible for the injury.

Horses that are wide between the front legs, such as draught horses, seldom hit themselves, but some thoroughbreds have their fore legs very close together, and they often knock themselves about severely. Too broad shoes, or too heavy, or shoes that have been on too long, and that have worn to a knife edge, and clinches that have risen up, are all fruitful causes of brushing.

A reliable method of ascertaining what portion of the striking foot actually does the hitting is smearing the offending foot with a mixture of pipeclay and oil, jogging up and down, and then searching the opposite limb for marks.

Horses that turn their toes in (pigeon-toed) hit with the inside toe, while those who turn their toes out (lady-toed) strike with the inside quarter or heel. Bad and indifferent horsemen are also a frequent cause; they are unable to make a horse go in a collected manner, by a nice feel on the mouth and making him go up to his bit, but allow him to go anyhow, all over the place. They are also incapable of gauging the correct pace of any particular horse, and are either continually forcing him over it, or else they allow him to go in a slovenly manner under it.

Brushing is a serious affection; a hunter of six or seven years of age which hits himself in front, and shows evidence of it in enlarged fetlock joints wider at the back, should never be purchased—he is unsafe to ride, and will only prove a constant source of trouble. In heavy ground, and when tired and overweighted, horses frequently knock themselves, but this is

accidental, and not to be confounded with the condition of brushing proper.

'Speedy cut' is generally the worst result. Swelling and serous abscesses (hæmatomata) also occur on the leg. Constant bruising may eventually lead to abscess formation. Splints, too, are frequently due to high brushing. Lower down on the fetlock the skin may be incised by the edge of a shoe, and in aggravated cases there may be an opening of the fetlock joint, and escape of joint oil or synovia. When the brushing occurs on the coronet, separation occasionally takes place between the horn and the hoof. When the hoof alone is affected but little injury is done.

Treatment. — Having ascertained by careful examination the cause of the brushing in the particular case, we must do all that is possible to remove it.

In young 'green' horses, which are not in condition, care should be taken to see that the food is plentiful and of the right sort, the corn being gradually increased with the amount of work done. A Yorkshire boot should be worn on all four fetlock joints if necessary. This can easily be cut out of a piece of old rug, about 6 or 7 in. wide, and the ends rounded off, and then wrapped round the fetlock, unfolded, and tied by a piece of tape passing twice round the middle; the upper half is then folded down over the other, and a neat and effective protection to the joint is assured. It will prevent further injury until the youngster gets into better condition, and with good riding or driving he should grow out of it.

Attention to shoeing is a great help in all cases of brushing. When the feet are big and wide, the wall should be rasped away from the inside toe to the heel; a quarter of an inch or more can thus easily be gained from each foot, and in the case of the hind feet more, as the thickness of the wall is greater. The inside web of the shoe should be straightened, and should lie somewhat under the edge of the wall; it may be feather edged, and thickened at the heel, to a level with the outside calkin, so as to ensure a perfectly level bearing. This is absolutely necessary. The nails on the inside must be placed at the inside toe, two or three will be quite sufficient; if the striking is done by the quarter, two nails may be driven in the toe, and one or two in the heel. Should there be any difficulty experienced in keeping the shoe in position, a quarter clip should be forged on the outside, which will prevent the shoe slipping over towards the inside. If the striking is done with the heel, a three-quarter shoe may be tried. A Lacomb rubber pad is sometimes useful in preventing brushing. It consists of a projecting piece of rubber between the shoe and the foot.

In those cases where the legs are very close together, or the feet turn out from the fetlock, boots must always be worn at work; the best are made of felt, protected with leather where most wear comes. They are fastened with leather straps and buckles, which should never be too tight. Leather boots nearly always rub when worn for long at a time. Indiarubber are good, but require frequent oiling to keep them soft. Bandages confine the joint too much, if put on low enough to be of use, and cut out quickly. Large rubber rings are sometimes worn around the pastern or above the fetlock, but they are unsightly and of little use.

In brushing behind, the faulty conformation either lies in the hock or the pelvis; a narrow pelvis generally means the hind legs too close together. A very useful boot for the hind legs is made with a broad leather strap buckling above the fetlock, to which is attached on the inside a thick oval rubber ring. It does not hold the mud, and does not slip round when going through dirt, as is so often the case with the short rubber fetlock pads.

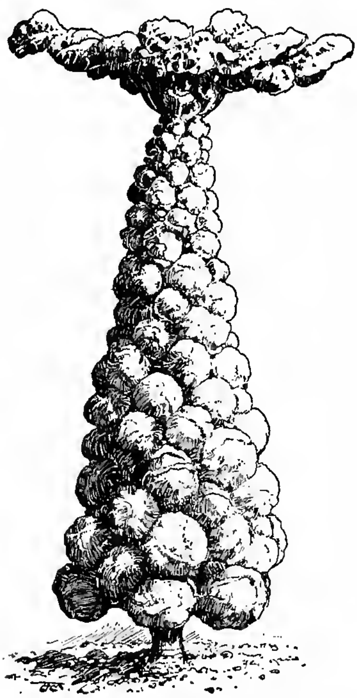
In cases of lameness the horse must rest, and the joints be well fomented, a hot-water bandage being left on, with a dry one on top of it. This may be repeated four or five times daily for two days. Recourse may then be had to the cold-water hose, twice daily for twenty minutes at a time, and the part subsequently rubbed dry with a little belladonna liniment.

In those cases where wounds are present, they must be well cleansed with warm water and some antiseptic, and dressed with a lotion of chloride of zinc, 10 gr. to the ounce of water. In bad cases, if there is much enlargement of the joint, the horse must be laid up and blistered with a cantharides blister, preferably with one prepared from the Chinese fly; this in due time should be followed by a run at grass, if the season permits. Occasionally in bad cases bony enlargements or exostoses are formed, and the only treatment for these is to point, fire, and blister.

Brushing should never be looked on lightly; it is a serious affection in both saddle and harness horses, and may end in incapacitating the horse altogether. [H. L.]

Brussels Sprouts.—This vegetable has long been cultivated on a large scale near Brussels, the place from which it derives its name. It was grown there in the year 1213, but whether it originated there is not known. It is a form of the common cabbage (*Brassica oleracea*), with a stout, elongated stem, on which are produced numerous buds in the form of miniature cabbages, the leaves being folded closely one over the other so as to often look like green balls. The formation of buds on the stem is not peculiar to the Brussels sprouts; it also occurs on Borecole and some forms of Broccoli; but by cultivation and selection the 'sprouting' character has been markedly developed in the Brussels sprouts, a good example being shown in the figure herewith. Brussels sprouts are almost, if not quite, as hardy as the Borecole; they are therefore grown for a winter supply; indeed the quality of the sprouts is improved by frost. They will grow in any garden or field soil, cropping just as freely on a light sandy loam as on the heaviest soils. Of course, where the soil is poor, manure must be added, although its application in large quantities is not advisable, as it induces too luxuriant a growth, and the production of large, loose sprouts instead of the nut-like, compact

balls that are in every way preferable. Seeds should be sown towards the end of March, and again early in May, so as to get a succession. In Scotland they are sown in August out-of-doors, and the seedlings transplanted in spring. They require plenty of room, 3 ft. apart being none too much, and their treatment generally afterwards should be similar to that recommended for Borecole. The sprouts when gathered should be cut so as to leave a short stump behind, as this will again develop buds.



Brussels Sprouts—Sutton's Matchless

If pulled off, the second crop is sacrificed. A selection of the best sorts would include: *Market Favourite*, largely grown by London market gardeners; *Aigburth*, one of the hardiest and most productive; *Exhibition*, a very hardy and free variety, the sprouts firm and of delicate flavour; *Sutton's Matchless* is an improved form of this. [W. W.]

Brydon, James (1807–87) was a prominent sheep-farmer and breeder of Cheviots. He occupied large holdings (Moodlaw, Kinnelhead, Thirlstanehope, Kirkhope, Lochanhead, Appin, and Holm of Dalquhairn) in Dumfriesshire and Kirkcudbrightshire, and for many years his stock took the highest places in the show and sale rings. As his rams were bought —as many as 160 and 180 every second year— for every sheep-breeding district in Scotland, Mr. Brydon was the greatest influence of his time among Cheviot sheep. [W. B.]

Bryobia prætiosa (the Gooseberry Red Spider).—This mite is commonly found on ivy, but in dry seasons is sometimes exceedingly destructive to gooseberry bushes, occurring in myriads on the leaves in spring. When young the mites are six-legged, but the fully grown creatures have eight legs, the front pair being much longer than in the well-known Hop Red Spider (*Tetranychus telarius*). They are adult in May and June, when their glossy red eggs may be found on the leaves. As soon as the pest is observed, the bushes should be washed with soft soap and paraffin emulsion, or with one of the customary hop washes. [C. W.]

Bucht, a Scotch term denoting a stone wall enclosure into which sheep are gathered for any purpose arising out of the management of sheep stock, such as clipping, dipping, &c. There are usually several compartments to facilitate operations. The corresponding English term is 'stell'. See STELL.

Buckbean. See MENYANTHES.

Buck-jumping, springing from the ground with all four feet close together; arching the back, and coming down again with the feet firmly planted, in a manner best calculated to unseat a rider or get rid of a load. This vice, as it is called, is particularly developed in some breeds of horses, and has a more or less geographical distribution. Australian, South American, and South African horses are disposed to this unpleasant trick, but it is comparatively unknown among European animals, Arabs, Barbs, or East Indian horses (Capt. Hayes on faults of temper). The authority just quoted says: 'The means I have found to be most efficacious in eradicating it are: giving the horse a good 'mouth', proving to him that, despite all his efforts to do so, he will be unable to buck while a man is on his back; and producing on his mind a strong impression of our power over him'. See also BREAKING. [H. L.]

Buckland, Dr. William (1784–1856), a celebrated geologist, successively lecturer on mineralogy and professor of geology at Oxford. He published numerous papers dealing with geological discoveries, and was the most advanced geologist of his time. To him belongs the honour of having first discovered the coprolites in Cambridgeshire and their manurial value for agricultural purposes. He was also one of the first to investigate the cause of potato disease. [R. H. L.]

Buckthorn (Rhamnus), a genus of the Rhamnaceæ, or Buckthorn family, which is widely scattered over the globe, but is confined in Britain to the single genus Rhamnus. This consists of shrubs with alternate undivided leaves and small green flowers on short pedicels usually clustered in the leaf-axils, and bearing a little pea-like, blueish-black berry or drupe enclosing three or four small one-seeded nuts. There are two British species, the Common Buckthorn (*R. catharticus*), with spreading branches, and branchlets often ending in a thorn, stalked, ovate or pointed, serrate, glabrous leaves, with few prominent veins, greenish-yellow flowers, and small black fruit; and the Alder or Breaking Buckthorn (*R. frangula*), which is more erect and not thorny, has broader, more obtusely oval, entire or slightly sinuate leaves, often somewhat pubescent on lower side, and with

numerous lateral veins, small whitish flowers, and dark-purple fruit. Both are comparatively rare in Scotland and Ireland, but occur more frequently in England, especially the Alder Buckthorn, and are there often found in hedges, thickets, and underwoods. The berries of both are strongly purgative (hence *catharticus*), as also the decoction made from the bark. The buckthorns are now of little use in coppices, but formerly their wood was valued for the finer kinds of gunpowder charcoal, and sold along with cornel as dogwood (which see). Buckthorn is not now, as formerly, a special object of cultivation, and it is not a good hedge plant owing to its rather straggling growth. See also Sea Buckthorn. [J. N.]

Buckwheat, Brank.—The several species of Buckwheat mentioned below belong to the nat. ord. Polygonaceæ, which includes docks, knotgrass (*Polygonum aviculare*, L.), Black Bindweed (*P. Convolvulus*, L.), and a few more familiar weeds of the farm. The following are the chief species met with in cultivation: (*a*) Common Buckwheat (*Polygonum Fagopyrum*, L.; *Fagopyrum esculentum*, Mœnch); (*b*) Tartarian Buckwheat (*P. tataricum*, L.); (*c*) Notch-seeded Buckwheat (*P. emarginatum*, Roth).

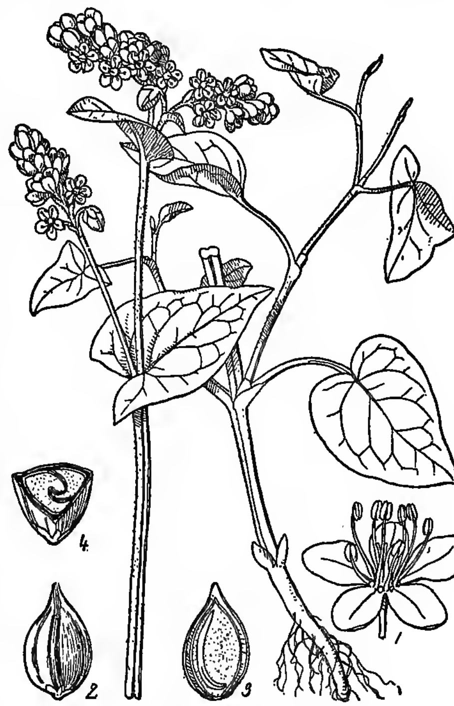
They are all Asiatic plants, native in the temperate parts of China, north-west India, and Central Asia, from whence they were introduced to western nations. The prefix 'Buck' is a corruption of the German word *Buche*, which means beech, the fruit of the plants being similar in shape to a small beech nut.

1. Common Buckwheat is an annual plant with smooth, pinkish stems, which grow to a height of 2 or 3 ft. The leaves are heart-shaped, alternately arranged on the stem, and having characteristic membranous sheaths (the *ocreæ*) at their base. The flowers grow in crowded panicles. Each flower possesses five pinkish-white sepals, eight stamens, and an ovary which when ripe forms a nut of triangular section containing a single endospermous seed. The nuts are usually dark-brown or black, but in some varieties they are of a silvery-grey colour.

Buckwheat is cultivated for the fruits or 'grains', which are used in many parts of the world as an important bread-corn, cakes and porridge being made of the starchy endosperm within them. The grain is also utilized instead of oats, or mixed with the latter, for feeding horses. In a cracked or broken state it is excellent food for milk cattle and pigs, and is extensively employed as poultry food.

The crop in a young green condition is occasionally fed to stock, but when fully developed the haulm and husks of the ripening grain contain a poisonous substance which produces dizziness, swelling of the head and neck, and even death when taken in considerable quantity. In this country Buckwheat is now chiefly grown as food for pheasants and other game on pieces of waste land round coverts, or on poor sandy land, where it is ploughed in green to increase the humus in the soil and improve the tilth and fertility of the latter. In some districts small areas are sown to provide honey for bees. The flowers are produced in succession for several weeks, and secrete honey from glands between the bases of the stamens.

Buckwheat is very sensitive to low temperatures, and is generally destroyed completely by a single night of frost. The seed must not be sown earlier than the middle of May or beginning of June. The crop grows very rapidly when the temperature and other conditions are suitable, and is usually ripe in twelve to fourteen weeks from the time of sowing the seed. The soil most adapted to the growth of Buckwheat is a warm, sandy loam; it will grow on dry sands and gravelly areas where other crops would yield little or no produce. Cold, wet soils are unsuited to it, although it will often thrive on peaty heathland containing acid humus.



Buckwheat (*Polygonun Fagopyrum*)

1, Flower. 2, Fruit. 3, Long section of fruit. 4, Cross section of fruit.

Where grown on a large scale for seed, it may follow vetches, clover, and rye grass, or take the place of a spring-sown cereal. The land should be ploughed early and reduced to a fine tilth. On the Continent, where the crop is an ordinary one of the rotation, the land is ploughed in winter, and then again in spring once or twice before being thoroughly harrowed and rolled. Manures are rarely applied, the residues from previous applications being considered sufficient. Nevertheless, on the poorest types of soil the use of potash, phosphates, and nitrogenous manures is remunerative. About a bushel of seed is neces-

sary to sow an acre. It should be drilled in rows from 12 to 15 in. apart. Little moisture is needed for germination, and the seed should not be buried too deeply, a covering ½ to ¾ in. being sufficient. For green manuring it may be sown broadcast up to the middle of July at the rate of 2 or 2½ bus. per acre, and should be ploughed in when the plants come into flower.

Buckwheat has the peculiar character of producing a succession of flowers right on into late autumn, so that on the plants seed in all stages of ripening are found when the time for harvesting arrives. The best time for cutting is about the end of August or early in September, when the first ripe seeds are beginning to fall. At this period the greatest number of ripened seeds are present. As parts of the plant are still green when the crop is cut, care is needed in harvesting. After mowing, the crop is turned several times, as gently as possible, for the first day or two, and in many districts it is placed in loose heaps, through which air can circulate freely before stacking in round small stacks. Not infrequently ten to fourteen days are essential for the proper harvesting of the crop. The yield of seed is very variable, the average being from 3 to 3½ qr. per acre, although on poor soils in a bad season it may be very much less, while on better land in a good year as much as 6 qr. or more may be obtained.

The grain of Buckwheat contains about 13 per cent of water, 4½ per cent albuminoids, 35 per cent of carbohydrates, and 43½ per cent of fibre.

The lateness of the season at which it may be sown, its adaptability to dry soils in poor condition, and easy cultivation, along with the feeding value of its grain, are points in favour of the more extensive growth of the crop. The yield is, however, erratic, the abundant setting of seed being dependent on climatic conditions which are not always prevalent. Moreover, the crop dries the soil and renders it very open and loose. It cannot be recommended for cultivation on good land on which the ordinary farm crops grow satisfactorily, as the economic return from these would be greater than from Buckwheat. There are, however, considerable tracts of sandy land, especially in the eastern and southern parts of Great Britain, on which the growth of the crop would be profitable, and its cultivation deserves more attention than it receives.

2. Tartarian Buckwheat is an annual plant wild in Tartary and Siberia, and has not been cultivated for so long a period as the common species. It is hardier than the latter, and has a greener, taller stem, with slightly broader leaves. The fruits are somewhat smaller than those of common Buckwheat, and contain less meal. They are slightly rough, and notched at the edges, and are not infrequent as an impurity in commercial samples of common Buckwheat.

3. Notch-seeded Buckwheat is also an annual species grown largely in China and north-east India. The grain is large, with winged edges, which are deeply notched. It does not thrive or set seed freely in this country. [J. P.]

Buddeised or Buddised Milk.— Among the methods which have been brought forward for the preservation of milk and its safe use by consumers, probably the latest that has been devised and put in practical operation is that which has received the name of Budde's process, the milk so treated being known as Buddeised milk. The inventor of the system is Mr. C. Budde, D.Sc., chemical engineer, of Copenhagen. The main principle of the system is the germicidal power of nascent oxygen upon milk at an optimum temperature of 122° to 125° F., the source of the oxygen being a certain amount of hydrogen peroxide which is added to the milk.

The mode of treating milk by this system, as carried out practically in some parts of Denmark and in Edinburgh, where Budde's patents are being operated, may be described shortly as follows: The raw milk is brought from the byres or milking-sheds immediately after milking to a central depot, where at once it is passed through a heater at a temperature of 122° F. It is then put into a centrifugal machine, which differs only from an ordinary separator in that it has only one opening, so that the cream is not separated from the milk. In this centrifugal machine, which revolves at the rate of between 5000 and 7000 revolutions per minute, all the 'dirt' and many microbes in the milk are got rid of. This process over, the milk is next placed in a vat which is provided with a mechanical stirrer. The vat is surrounded by a water-jacket, and by the introduction of steam the temperature of the milk may be maintained at 122° F. The vat is made strong enough to withstand the pressure of one atmosphere. Either immediately before the milk is put into the vat, or soon thereafter, a certain amount of pure neutral hydrogen peroxide is added to the contents of the vat. All air is now pumped from the vat, and the contents are thus under a vacuum during the whole time they are within the vat. This vacuum ensures that gases generated in, or liberated from, the milk escape as they are formed. The milk, maintained at the temperature of 122° F., is kept in the vat for three hours, during which period the stirrer is occasionally set agoing, in order to produce a homogeneous mixture, and also to effect complete sterilization by the hydrogen peroxide. At the end of the three hours, air rendered sterile by being passed through a cotton-wool filter is admitted into the vat, and the milk is now passed through sterilized tubes into sterilized bottles provided with air-tight stoppers. These bottles and their contents are now rapidly and thoroughly cooled. The bottles, which are returned empty, are cleansed and sterilized by mechanical appliances, devised by the inventor, before being again used. Before the milk is bottled, however, a small quantity taken from the vat is tested for any hydrogen peroxide which the milk may not have acted upon. This is necessary and advisable, because any peroxide not acted on, even in such minute amount as 0·0006 per cent, imparts a metallic taste to milk. If any surplus of the peroxide be found, a minute

amount of catalase solution is added to the milk in the vat to decompose it. This catalase is readily obtained and prepared from any fresh tasteless vegetable substance by extracting the vegetable substance with sterile water, precipitating the dissolved catalase with ammonium sulphate or alcohol, filtering off the precipitate, drying it, and again extracting the residue with a mixture of glycerine and water. Two or three drops at most of this solution are sufficient to decompose any remaining peroxide in two gallons of milk.

Hydrogen peroxide has the chemical formula H_2O_2, a combination of equal volumes of hydrogen and oxygen, and when it is decomposed loses its oxygen thus:—

$$\frac{H_2O_2 = H_2O + O}{H_2O_2 = H_2O + O} : O + O = O_2;\ \text{or, } 2H_2O_2 = 2H_2O + O_2.$$

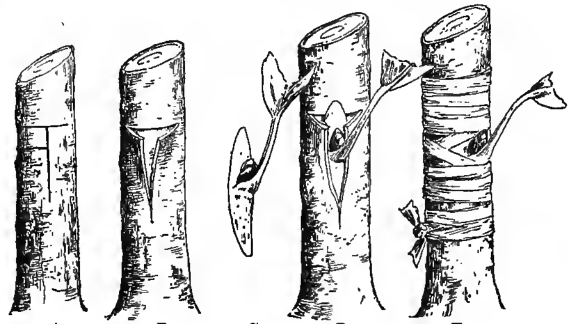
It is now well ascertained that during the nascent state oxygen has greater bactericidal action. It is essential that the peroxide should be pure and have a neutral reaction. Commercial peroxide, which can now be readily procured of this quality, is ordinarily of ten-volume strength, or approximately 3 per cent. The amount of the peroxide solution to be added to the milk should be just sufficient to sterilize it, or at most be a very little over. The average amount needed for this purpose is about 0·03 to 0·04 per cent of available peroxide. A little calculation is required to arrive at the amount of the peroxide solution to be added. During his researches toward instituting his system, Budde found that by placing samples of milk treated by different germicidal fluids and by hydrogen peroxide in a thermostat at 100° F., the samples treated with other germicides kept for a shorter time than at ordinary temperatures, whereas the sample treated by peroxide kept fresh for a longer time than at ordinary temperature. He further found, that after using peroxide, and on raising the temperature of the thermostat to 115° F., the milk was rendered sterile. Living or natural milk contains an enzyme or ferment catalase which has the power of decomposing a limited amount of peroxide, and thus liberating nascent oxygen, and at 122° to 125° F. possesses the power to decompose sufficient to effect its own sterilization.

Hydrogen peroxide differs from other substances which have been advocated for preserving milk, such as boric acid, formalin, and others, in that it cannot act hurtfully or poisonously on the users of milk so treated, since the peroxide is decomposed in the living tissues of the body. This has been proved by many personal experiments by observers.

In the amount used, and in the mode of treatment of the milk in the Budde process, the peroxide has no inimical effect on the normal constituents of milk. It does not alter the diastase, or the casein, albumin, fat, or sugar, or contained salts or acids, nor, when treated as described, does it impart any disagreeable taste to the milk. Rennet, however, curdles Budde-ised milk somewhat more slowly than raw milk, but more rapidly than Pasteurized milk. In short, the Budde process renders milk absolutely sterile. This has been proved by many experimenters, notably Fischer of Berlin, Levin and v. Stein of Copenhagen, Rideal and Tanner Hewlett of London, under rigid conditions of test. From our own experiments with samples obtained from the inventor of the process we can corroborate the statements of these observers. Moreover, milk so treated has been for a considerable time now used for human food. It has been largely used at the Silkeborg Sanatorium, Denmark, for consumptives; and also for the feeding of infants. Among others who have continuously employed it for that purpose for some months with success is Dr. Robertson, medical officer of health of Leith, who reports that he is now feeding infants on pure undiluted cow's milk prepared by the Budde process, with the addition merely of some sugar, and that the results are good.

[J. GI.]

Budding.—This is one of the most useful methods of propagation, being largely used for the multiplication of fruit trees, roses, and named varieties of ornamental trees. It consists of the removal of a bud with a portion of the bark attached, and inserting it beneath the bark of another plant, the main principle being the same as in grafting. The union is effected by the growing together of the cambium layers under the two barks, which readily takes place if they are in a suitable condition. This is when the bark separates readily from the wood, which is at the time when growth is most active. Warm weather is therefore most favourable for the operation, the bulk of it being done in the months of July and August. What is known as shield budding, represented in the figure, is the easiest and most generally practised method. A shoot is taken with buds of the right character, and the buds are sliced off as shown in B, the bark being then removed from the portion of wood attached. A slit is then made with the point of a knife in the bark of the stock, and a transverse notch enables the operator to slip the handle of a budding-knife under the bark so as to raise it. The bud is then forced down wedge end first until the



A B C D E

Shield Budding

whole of the bark is underneath that of the stock and lying flat against the wood. The operation must be quickly performed or the bark will dry. After the bud has been inserted it should be bound round with fine matting or worsted, not too tightly, but with just sufficient pressure to hold the whole together. Of course the binding must leave the bud itself lying at the axil of the leaf-stalk quite free. In a month or six weeks a union will have been effected, when the binding may be removed. In the following spring the branch of the stock containing the bud should be cut back to within 2 or 3 in. of the bud. [W. W.]

Buddleia.—A genus of useful garden shrubs, some of the best of them being quite hardy in the warmer parts of the country. They are excellent for seaside gardening. The best known is *B. globosa*, which forms a spreading bush 10 ft. high, with oblong green leaves, silvery on the under side, and tassel-like globular heads of orange-yellow, honey-scented flowers. *B. variabilis* and an improved form of it known as *Veitchii* are loose-growing shrubs with long, wand-like shoots clothed with long, lance-shaped leaves, and bearing very large racemes of bright purple flowers suggestive of Lilac, but more elongated, being sometimes a foot or more in length. *B. Colvillei* is the most beautiful of all, but unfortunately it is too tender to be grown outside in the British Islands except in the south and west, where it forms a big, rambling shrub, with long, narrow green leaves and drooping panicles of crimson flowers suggestive of pentstemons. [W. W.]

Buffalo.—Setting aside the American Bison, which is wrongly called Buffalo in the United States, the true buffaloes may be defined as species of wild cattle in which the horns, whether long or short, are massive, rugose or ridged, and trigonal in section, at least at the base; the coat in the adult is coarse and scanty, the build heavy, and the withers not markedly raised above the level of the hind quarters. Buffaloes, sometimes included in the genus Bos, sometimes referred to a separate genus Bubalus, are divisible into two distinct groups, typified respectively by the African species, *Bos caffer*, and by the Indian species, *B. bubalus*. African buffaloes are distributed in suitable districts all over the continent south of the Sahara, from Abyssinia in the east to Senegambia in the west. According to locality, they differ from one another in the matter of size and of colour, and especially in the breadth, length, and curvature of the horns. It is asserted, indeed—and the assertion does not lack probability—that the buffaloes of the different African river systems can be distinguished from one another by the structure of these organs. However that may be, it is certain that two very distinct types are exemplified respectively by the large Buffalo of the Cape (*B. caffer*) and by the dwarf Buffalo of the Congo (*B. nanus*). The Cape Buffalo, formerly abundant in the colony, but now restricted to the Knysna forest, the Addo bush, and a few other localities, where it is strictly protected, is black in colour, and stands about 5 ft. high at the withers. The horns, especially in old bulls, are very wide at the base, and form an expanded, rugose, helmet-like mass on the forehead, where they are almost in contact in the middle line. From the base they incline downwards and backwards, then forwards and upwards to the tip, the part that is clear of the head being smooth and rounded. Buffaloes closely resembling this type are found throughout East Africa as far north as Uganda. The dwarf Congo Buffalo, on the other hand, is yellowish or red in colour, stands only about 3 ft. 6 in. at the withers, and has the horns very much shorter, flatter, and less expanded at the base, with the short terminal portion directed upwards. Different, nevertheless, as these two buffaloes are, they seem to be linked together by a number of intermediate types, which makes it impossible to draw a hard-and-fast line between them. For example, the Buffalo of Abyssinia, the Soudan, and the White Nile, which has been termed *B. æquinoctialis*, stands about 4 ft. high, is blackish or brownish in colour, with the horns medium-sized and only moderately expanded at the base. Without, however, mentioning in detail all the transitional forms, it will be sufficient to say that the African buffaloes are usually referred to a single species, *B. caffer*, which is locally represented by a variety of sub-species. One of these local transitional types is shown in the accompanying figure of a Senegalese Buffalo (*B. caffer planiceros*), which is black in colour, stands about 4 ft. 6 in. at the shoulder, and has the horns massive, short, and flat.

Indian Buffaloes (*B. bubalus*) are larger than the African species, some bulls even exceeding 6 ft. at the withers. They also differ in other respects, notably in having smaller, narrower, and less hairy ears, the facial portion of the skull longer, and the hair along the spine growing forwards from a whorl situated a little in advance of the hind quarters, instead of lying with their points directed backwards. The horns are of two types, the one being short, massive, and almost circularly curled on each side of the head, recalling somewhat those of the Cape Buffalo; the other curving outwards and backwards with a bold sweep, and tapering gradually from the base to the tip, which is bent upwards. Individual horns of this kind may measure as much as 6 ft. or more in length, and the spread from tip to tip, when the curvature is slight, may be as much as 9 ft. But the horns, whether short and curled, or long and extended, arise from the sides of the head, and do not form the massive frontal boss or helmet characteristic of those of the South African buffaloes. To Indian buffaloes of the long-horned type, which seem to be practically extinct in a wild state, the name *macroceros* has been given; and the name *spiroceros* has similarly been proposed for those with the short curled horns. But the relationship of the one kind to the other is not clearly understood. The colour, both of the long-horned and of the typical short-horned races, is black, with a tendency sometimes to dirty-white about the legs; but a third race, which is dun or tawny in hue, and has a much shorter face, with the area between

the horns convex, has been described as *B. bubalus fulvus*. It comes from Upper Assam, and has the horns short, massive, and curled. Buffaloes are not known in a wild state in southern or western India, but were formerly at all events abundant in the plains of the northern and central portions of the country, as well as in the north of Ceylon. But in the latter locality, as in parts of Burma and the Malay Peninsula, where wild buffaloes occur, they may be feral domestic animals. Both Indian and African buffaloes live in the plains, and are never found far from water, being particularly addicted to swampy country. They feed principally in the evening and early morning, and spend the hottest part of the day wallowing in the mud, or buried with only the tops of their heads projecting above the surface. Indian buffaloes mate in the autumn; the calves, one or more rarely two in number, are born in the following summer, the gestation period being about ten months.

Unlike the African species, Indian buffaloes have been domesticated in their native country from time immemorial, and have been introduced into many of the warmer countries of the Old World, notably into Italy in the 6th century, and also into Hungary, Roumania, Tunisia, Egypt, Syria, Java, and North Australia. They are principally used as beasts of draught and burthen; but in various parts of the East, trained buffaloes are kept for fighting in the arena with tigers and other animals, for the amusement of wealthy potentates.

In addition to the Indian Buffalo, Asia possesses a species in the Philippine Islands (*B. mindorensis*) which, while possessing the same general characters as the Indian species, is a much smaller animal, standing only about 2½ ft. high, and having the short but massive horns directed straight backwards from the head in the same plane as the forehead. This species serves to connect the Indian Buffalo with the Anoa (*B. depressicornis*) of Celebes, which, with horns of the same general form as in the Philippine species, is a still smaller, slighter animal, standing about 3 ft. at the withers, and exhibits several structural features showing decided affinity with the tragelaphine or eland-like antelopes. Unlike the Bison, buffaloes do not hybridize with domestic cattle. [R. L. P.]

Buffing.—This is a term used in the manufacture of leather, and refers particularly to removing a layer or reducing the thickness, as in preparing what are known as 'split skins' in the trade. Buffing also means packing to prevent concussion, and is in this sense employed in connection with shoeing lame horses, when tow, felt, rubber, or leather is used between the shoe and the hoof. [H. L.]

Bugloss, the common name of the genus of plants botanically called Anchusa. See ANCHUSA.

Buildings, Farm.—Under this heading it is proposed to treat of the steading only, that is, of that portion of the homestead devoted to the use of farming stock, dead and alive. It is impossible to overestimate the importance of these buildings. They are the farmer's manufactory, and with their suitability much of his success will lie, not only as regards the welfare of his stock, but as regards the cost of administration; for which reasons, not only should the various buildings comprising the steading be thoroughly adapted to their separate use, but they should be grouped to the best advantage for economical working, and it is in this respect that much of the skill of the designer will have to be brought to bear.

It may perhaps be well to summarize what should be the qualifications of a person aspiring to design a complete homestead. Firstly, he should be intimately acquainted with the farming practice of the neighbourhood, and able to pronounce authoritatively as to what buildings would be most suitable to the farm in question, and to the average tenant, giving both the character and the amount of accommodation, together with an opinion as to the best site.

As a rule, nothing would be more unwise than for a landlord to take a tenant's or a prospective tenant's advice as to the character of the proposed buildings, and more particularly so, should the tenant chance to come from a different part of the country. In any case the landlord is exposing himself to the risk of providing for a faddist, specialist, or one with some peculiarity of practice; and buildings would possibly be erected which might prove unsuitable for subsequent tenants, and thus the farm would not be permanently benefited. As a rule, tenants will ask for more accommodation than is really required, and though nothing is more unfair to the tenant and bad for the farm than insufficient accommodation, too much building not only tends to untidy management, but leads to a larger expenditure for repairs, and the useless buildings are soon allowed to fall to ruin from neglect. If a landlord or his designer is not competent himself, therefore, to judge of these matters, it would be well to seek expert advice before embarking on the large expenditure necessarily attendant upon the venture.

Secondly, the designer should be versed not only in the individual needs of each department that goes to make up a steading, but, as urged before, in the grouping and designing of them as a whole, so that collectively they may form the most compact and economical set of buildings possible, and be capable of providing sanitary housing for the live stock, that it may be maintained in the most healthy and therefore profitable manner.

And lastly, he should be well up in the matter of construction, that he may know how to design the buildings in the cheapest manner possible, consistent with permanency and stability.

SITE.—Before proceeding to discuss the arrangement and construction of the steading it will be well to deal with the question of site and with the position of the buildings on same. An ideal site would be a sheltered southern slope, easy of drainage, and with a dry healthy subsoil, such as gravel, a good water supply, having a position as near the centre of the holding as may be, and close to a good road. It is hardly to be expected that this combination

of good points will often be met with, but they should be looked for, and as many of them obtained as possible. In any case, a low-lying site, difficult of drainage and liable to heavy mists, should be avoided.

The main essential is, of course, a good water supply. In olden times this necessity was often provided for by grouping the buildings about some good pond, but in these days of cheap motive power, some further and better reason must be adduced for planning the buildings about visible water; though, of course, should there be a good pond on the holding, in the best position for the homestead, it is of the greatest value, if only it can be safeguarded against contamination from the yards.

At a cost of £35 to £40 a small oil or hot-air engine, with pump and rising main complete, can be installed, which will raise sufficient water to supply the needs of the whole homestead, including house, a storage tank being placed over the boiling-house, or some point from which it will be convenient to take supplies to different departments of the steading.

Nothing can be more convenient than having water under pressure in this manner laid on to all parts of the buildings; not only will it save an immense amount of time and labour in carrying, but it will conduce to the stock having a better and purer supply of drinking water. Where everything has to be carried, it is exceedingly difficult to get the men to give sufficient, or to clean out the drinking troughs as often as they should do, a difficulty entirely overcome where it is the mere trouble of turning a tap. In most up-to-date farms nowadays there is an engine of some sort for pulping, chaffing, grinding corn, &c., and of course wherever this is the case, it would be employed for raising water.

Another method of water supply is by gravitation from some source of supply on higher ground, in which method, to save trouble in the future, careful filtering should take place at the higher end, to prevent all grit and anything likely to choke the pipes getting into the system. Water may also be provided by windmill power, the original cost of which, with pump, &c., complete, is but little more than that given above for oil engine.

And lastly, hydraulic rams may be employed. Where a suitable head of water can be obtained (the head necessary is governed by the height to which water is to be raised), this is a splendid system, entailing little expense beyond the original cost.

Rainwater from the roofs will naturally be collected and stored, but it is in most districts too entirely uncertain to be regarded as a sufficient source of supply.

To have the buildings near to some good, hard-metalled public road is another important point. A farmer's private roads in and about his holding are a constant source of expense to him, and too frequently are they in such a condition that the labour of carting is greatly increased. This point will be fully appreciated by those who have had to do with farms set back some distance from the main road, particularly in the case of heavy-land farms. Nor is the reason for setting them back some distance quite apparent. In the accompanying plan of a homestead for a mixed farm of 250 ac., the west face of the buildings is shown built hard upon the main road, doing away with the necessity of a fence here, and any waste of land between the road and buildings. The only entrance direct from the main road other than the two main gates, which would be the same whether the buildings were set back or not, is that to the boiling-house, which entrance should be used infrequently, and of course not for stock at all. There does not seem much, therefore, in the contention that this plan keeps the main road in a dirtier condition, whilst it has the advantage of reducing to a minimum the roadways for access to the various departments.

As to the position of the buildings on the holding, there can be no doubt that on an arable farm they should be as near the centre as possible, and on dairy farms as central as possible to the various pastures, to avoid fetching and feeding the cattle from long distances.

If, however, the holding should be on the slope of a hill, the building should be nearer the top than the bottom, to save the uphill carting of manure from the steading. The reverse of this was the old rule, which meant that the crops were to be carted downhill, but in those cases where this latter carting would cause much difficulty, nowadays, with improved threshing machinery capable of turning out a sample fit for market, much grain may be stacked where it is cut, and dealt with from there.

The best aspect for stock is undoubtedly S.S.E., but when the homestead is built on a slope, unless the aspect is utterly wrong, it will generally be found best to place the buildings across the direction of the slope, or some very awkward levels and steps will have to be dealt with. In this case it should also be considered whether it may not be necessary to drain to either side of the building the higher ground at the back, so as to preserve the dryness and healthiness of the building site.

The Arrangement of Homesteads.—In designing a new homestead the whole object is the health and profitable maintenance of the stock, and economy in time and labour of attendance upon them. With this end in view, there should be an immediate connection between those buildings or apartments whose usefulness depends on each other, this being also kept in mind, that it is more important to save time in comparatively insignificant operations of frequent occurrence than in larger matters which are not often repeated. Thus the feeding troughs of the dairy cattle should be as directly and immediately connected as possible with the mixing floor, where the principal part of their food will be prepared; also the feeding troughs of the pig pens with the boiling-house, and so on; whilst access to the straw barn for litter should be provided for as conveniently as may be. The yards, too, should be grouped about the buildings in such a manner as to provide the readiest means of depositing in them soiled litter from the various stock sheds.

Most will be well acquainted with the old-time homestead, in which was generally to be found the large rambling old barn of flail-threshing memory, with perhaps cowsheds ranged about it, then the stables in an entirely separate block, the piggeries in another, the granary, chaff-cutting house, and cartshed in another, and various outlying loose boxes and small cowsheds wherever an odd corner was to be found.

In addition to this, the yards were nearly always of much too large a size, rain-washed, and wasteful of litter, all tending to the making of bad manure, whilst the aspect was often not studied at all. This arrangement is obviously not of a labour-saving character or suitable to the modern practice of farming. It means carrying fodder from the granary to both the cowsheds and stables, and from the mixing floor to isolated stock scattered about the homestead, and bringing straw from the stackyard and barn to all the various departments, which, besides entailing endless labour, keeps all the roadways in a constant litter.

Modern designers, in the attempt to remedy this, have, however, too often gone to the other extreme, and in many designs of recent years large homesteads have been planned with all the buildings, even down to the fowl house, grouped in one vast parallelogram, with but two or three external openings giving access to enclosed roadways or alleys. From these internal alleys are approached the yards, cartsheds—in fact all the various departments, and it may safely be left to the imagination of the reader to realize the indescribable filth into which these internal approaches must be churned, the insanitariness of it all, and the stagnation of the exhalations so enclosed. This arrangement is also most wasteful of roadway, for that surrounding the buildings must be maintained. In case of fire, too, not only is the whole range of buildings endangered, but the difficulty of dealing with the fire is greatly augmented, and unless removal of the stock can be undertaken early in the conflagration, much must inevitably be lost, while in any case the work of rescue would be seriously hampered.

Unless, therefore, the holding is situated on some of our bleakest wold lands subject to driving winds and rains, it would seem to be better that all yards and buildings should be approached from external roadways, as shown in the accompanying plans; and in the few cases where the accommodation required would largely exceed that shown on the plan for a 400-ac. farm, it would be well worth consideration whether the horse yards, stables, and cartsheds should not be dissociated altogether, being built in an entirely separate block.

The staff that works this department is entirely distinct from that having charge of the cattle, so that if the cartshed were built adjoining the stables, and a roomy loft constructed over the former into which a stack could be threshed direct, and a little hay stored, the extra labour involved would be trifling, as only chaff and corn would have to be carted from the granary, a very small matter. Indeed it is questionable whether there would be any extra labour, for where the parallelogram assumes such unwieldy size, the intercommunication between the various departments becomes so intricate that for all practical purposes they might be isolated. In favour of this latter scheme it may be a point worthy of note that gossip is less likely to interfere with work than when all the men are thrown together in one building, and tools are less likely to get borrowed and mixed by the different staffs.

In this country it will not be often that an entirely new homestead is required, most of the work needed being in the direction of remodelling and reconstructing. It is impossible in the limits of such an article as this to enter at all deeply into the latter question, nor perhaps is it necessary, for nothing but an intimate knowledge of the requirements of a complete homestead can be of real use and importance in the rearrangement of old buildings. Hence it may be re-urged that, to save the heavy cost and huge mistakes in so-called improvements such as one has seen of recent years, not merely in faulty methods of construction, but chiefly in unsuitability of design and arrangement, owners will be well advised to obtain the services of a really competent man who has made a study of the subject.

The only suggestion one would offer here, as to the rearrangement or rebuilding of old homesteads, is that the question of site should be carefully considered. Frequently this is never given even a thought; the buildings are re-erected on the old site as a matter of course, or an excuse is made that a few of the old buildings are too good to pull down; whereas the advantages outlined in the foregoing remarks on sites should be looked for on the holding, and if found in greater measure at some other point, no hesitation should be felt in rebuilding your homestead there, though you have to leave a few sound old buildings on the old site, which will prove useful for a variety of purposes.

Before passing to the consideration of actual plans and details of various departments, it would be well to have it clearly understood that all fittings should be of the simplest description. This may not apply to home farms where owners wish to make model buildings and cost is not such an important object; but in the case of all ordinary homesteads it is of the greatest importance not only to lighten the preliminary burden of cost, but to keep down the future cost of repairs. To this latter end all repairs should be easily within the power of the estate carpenter, or whatever is broken or missing is sure to be neglected until some serious mishap arises through its defect. Thus, if it is nothing more difficult than the nailing up of a plank, a tenant will always do it himself, but should it be anything less simple it is either neglected, or, the terms of the lease making it possible, the landlord will be burdened with it.

It may be worth mentioning, in connection with this matter of repairs, that where the lease makes the tenant responsible for repairs, it will be well worth while having a capable man to

inspect the premises yearly to see that the tenant is carrying out his obligations, and not allowing them to accumulate, as in this latter case, even if the tenant remains sound financially and the repairs are finally attended to, the state of the buildings will not be so satisfactory as if thoughtfully attended to from time to time.

The following plans have been prepared to show the general type and form of arrangement which may be followed under ordinary conditions. It is not probable that they will ever be entirely applicable to any actual holding, for, apart from the differing customs which prevail in every district, each requiring its own setting, there is the actual extent and physical aspect of the holding, which must finally settle the size and proportion of accommodation to

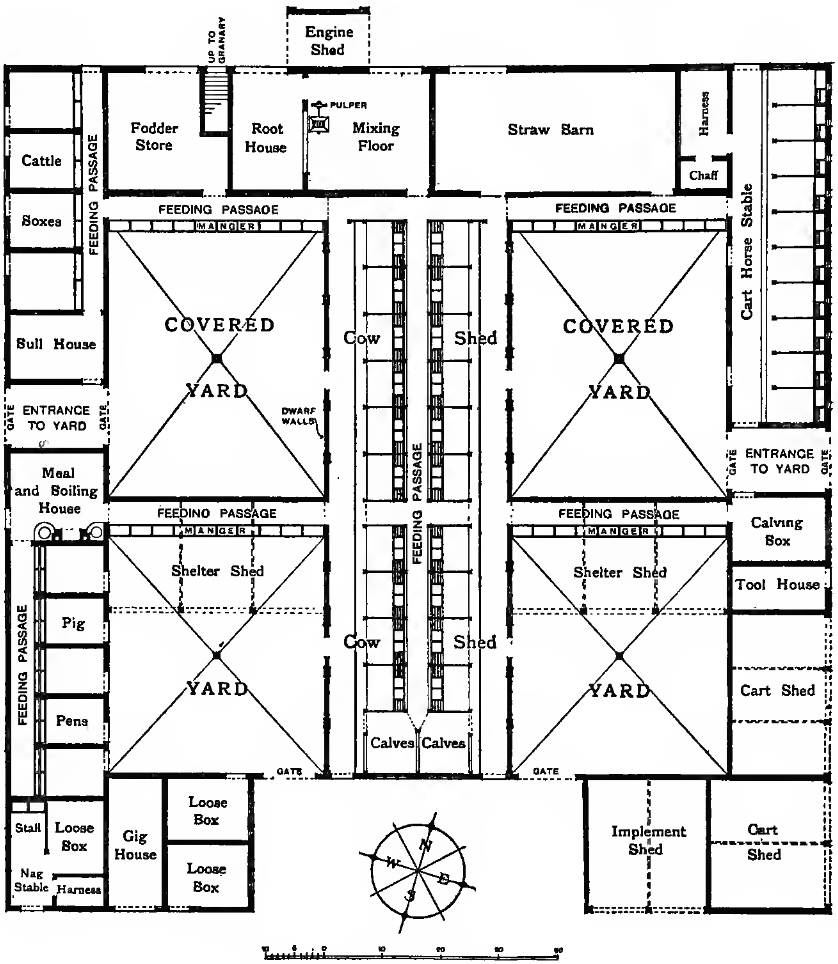


Fig. 1.—Arrangement of Buildings for a Farm of 400 acres

be allotted to the various departments. But it will generally be found that, by extension or modification of the various parts, they may easily be adapted to meet the requirements of any given case.

The first example, fig. 1, is for a mixed farm of about 400 ac. It will be evident at once that in this plan the *yards* are constructed without the use of fencing, being completely enclosed, except for the necessary gateways, by the buildings themselves. They might be open or covered as desired, though in this case the two lower yards are shown open with wide shelter sheds. The probable cost of carrying up piers above the roofs of adjoining sheds, and covering each yard of the sizes shown with steel and corrugated iron roof, would be about £80, or with steel and slate roof £130.

It will be seen that the *food stores* are placed in a two-story building on the north sheltering the yards. The *straw barn* is commodious, carried up the whole height of the building, and with direct access to cowshed for littering same, and convenient to the stables for the like purpose. The *mixing floor* has a door opening directly on to the feeding passage of the cow-

shed, and only separated from the *root store* by a dwarf wall over which to serve roots to the pulper. Wide access doors are provided for each department, for backing a cart to dump roots, or cart away prepared food as the case may be. A *fodder store* is provided for best stuff to be fed 'long' to the cattle, with access to feeding passage.

On the upper floor the *granary* extends over two end boxes and fodder store, the *cake room* with corn and cake crushing mills over the root store, the *chaff house* extends over the mixing floor, with end next the barn open, for loading or unloading under cover, and with shoots conducted down on to the mixing floor. There would also be direct communication between the granary and chaff house for trucking right through. The straw barn extends over the harness room, but not over stables. An open-ended portable *engine shed* is provided in the most convenient position for the shafting to work the various machinery.

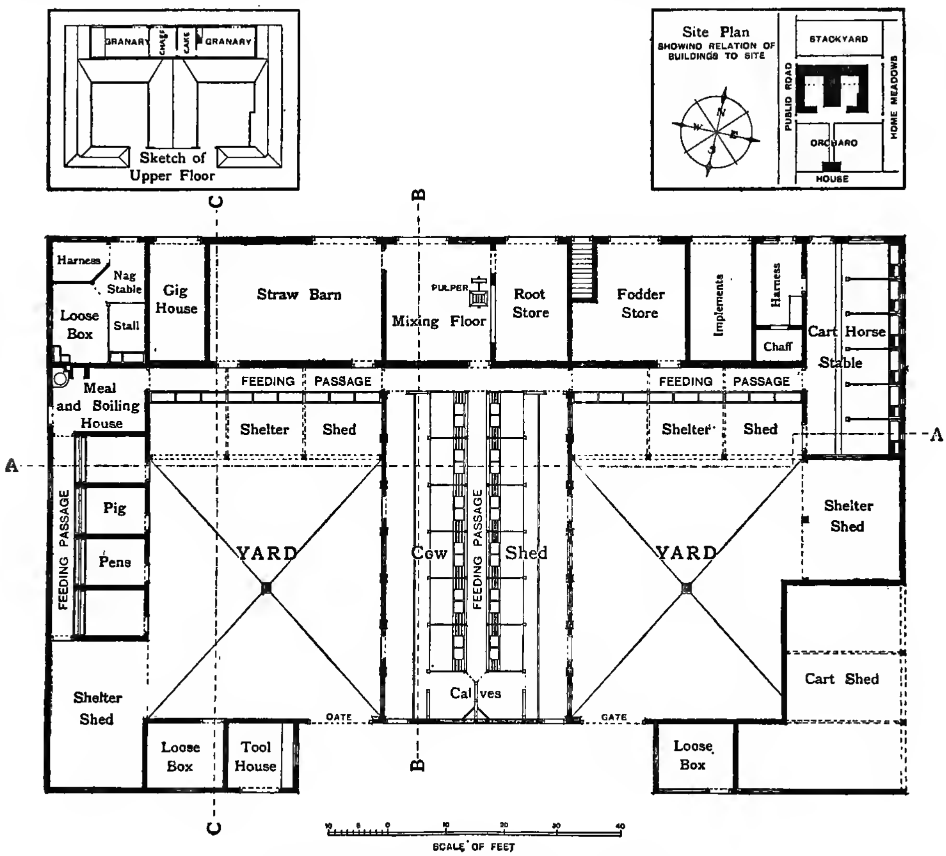


Fig. 2.—Arrangement of Buildings for a Farm of 250 acres

The *cowshed* is shown to accommodate forty cows, with central feeding passage directly connected to mixing floor, and two calf pens at one end. The upper part of the shed would have dwarf walls only between it and the covered yard, over which the dung would be cast to be trodden by the beasts in the yard. The lower part of the shed abutting on the open yards would have to be fitted with windows. It is proposed to admit light plentifully on both slopes of the roof. Four *feeding boxes* and *bull shed* are provided at the N.W. corner, connected with the food stores. By putting a gate at each end of the yard entrance adjoining bull house, a useful enclosure for serving cows would be formed.

The *boiling-house* is central, and convenient for access to all parts, with direct connection to feeding passage of five *pig pens*, which it would principally serve. The pens are divided from yard with 4 ft. 6 in. dwarf walls, and doors to allow of pigs running in yard when desired. If this yard is allowed to remain uncovered, shutters could be hung to the roof plate, to fit openings above dwarf walls, to swing inwards and fasten up against roof or let down in bad weather.

Stabling is provided for ten horses, with harness room and chaff bin attached, and exits to yards. Plentiful lighting would be provided in the slope of roof at back of horses, up-cast fresh-air inlets in front wall, and ventilation in

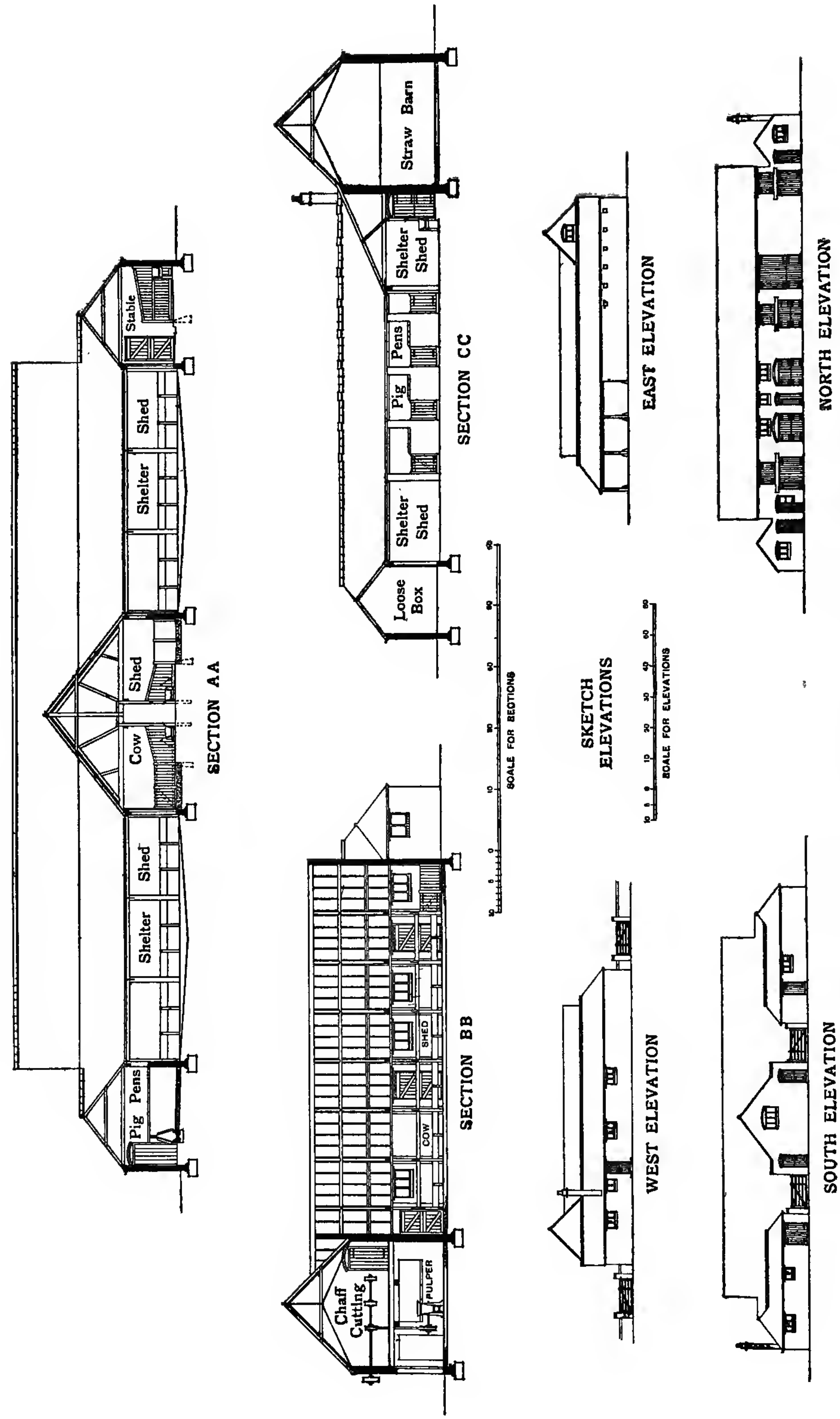


Fig. 3.—Front and Sectional Elevations of the Buildings shown in fig. 2

roof. The *cartsheds* face east and are adjoining the stables, and the *implement shed* is fitted with lock-up doors. A *tool house* is conveniently placed for both.

Besides mangers alongside feeding passages to yards, the further accommodation shown comprises roomy loose boxes suitable for foaling or calving, and *nag stable* and gig house. It is suggested that a loft should be constructed over the gig house and adjoining loose boxes, to hold hay and litter for these departments.

It will be seen that this scheme, besides being economical of building materials, lends itself also to most economical and orderly working, whilst in wet weather the work of the steading could be carried on in complete comfort, so long as the food stores hold out.

The probable cost of this building, just as described and drawn, built of brick and slate on proper concrete foundations, with the two upper yards covered with steel and corrugated iron roofs, and the whole fitted and finished complete with simple but suitable fittings, would be about £2250, though this figure could of course be very largely decreased by employing wood on brick pinnings to all the shedding save the two-storied north block, and covering the roofs with corrugated iron or some other cheaper substitute for slates or tiles.

The design of homestead for a mixed farm of about 250 ac. (figs. 2 and 3) is of the same arrangement as the larger plan just discussed, but confined to the limits of two yards. It will be seen that the buildings enclose the yards in the same manner, and though the yards are capable of being covered without any alteration of plan, they are in this case shown as open yards, for which reason they are provided with deep, comfortable shelter sheds, besides the ordinary feeding shelter. By temporarily blocking up the opening to yard of shelter shed in S.W. corner, a useful foaling or calving box connected directly with the food stores would be provided.

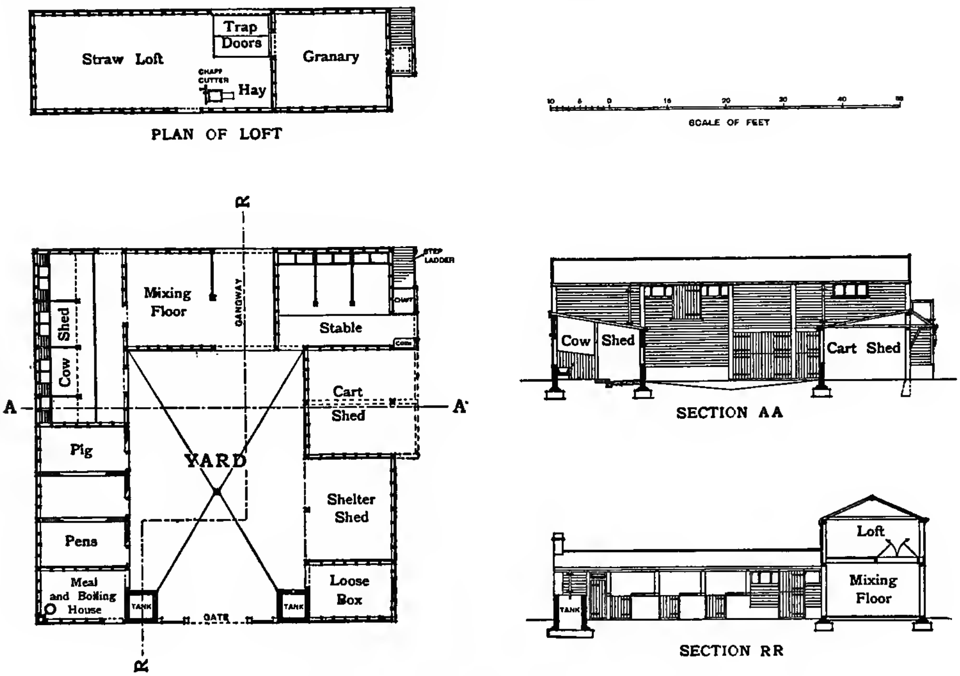


Fig. 4.—Arrangement of Buildings for a Small Holding of 70 acres

A site plan is also given in which the steading is shown built on the edge of a public road in the manner suggested previously, and the dwelling-house placed to the south of the buildings. By this arrangement the latter would escape, during all the prevalent winds, the nuisance of smells from the stockyards, and the annoyance of dust during times of threshing. The probable cost of building this steading in the substantial manner described before would be £1200.

Fig. 4 shows a design for a small holding of about 70 ac. In most instances a holding of this size demands an inexpensive set of buildings, and in order to show how this may be obtained, the drawings, including plans and sections, have been prepared, showing a timber construction on brick pinnings. If convenience and economy of labour is important in the case of the larger steadings previously described, it is certainly no less so in the case of the smaller steading now under consideration, and every labour-saving arrangement possible should be found in its plan, to keep down the labour bill, and make the greatest use of the personal labour of the tenant, which will count for so much in making such a farm pay or not.

The plan adopted is of the conventional shape,

in which the buildings enclose and shelter a yard, and with the administrative block on the north side two stories high. Part of the lower story is occupied by a mixing floor, and the remainder by stables and a portion of the cow stalls, while the upper story, which is a roomy loft with plate 6 ft. 6 in. high, is partitioned off into a granary over the stables, the rest to be used for a straw and hay store, and for chaff-cutting.

This presents a workable, compact, and yet economical arrangement, for a good deal of roofing is saved over the stable and cowshed, whilst the benefit of barn space is not lost with such a commodious upper floor as is shown. Hay or straw can be served direct from same into the different departments, or bundled out into the yard through side doors, and by providing large trapdoors over the gangway, as shown upon the plan of upper floor, a cart under cover may be loaded up from this floor with chaff or hay, and corn from the granary.

Chaff-cutting is carried on directly over the mixing floor, on to which a shoot would conduct the chaff, whilst the chaff for stables would be carried through the granary and shot through a trap into a bin provided for same. The mixing floor is paved with concrete, and with the movable partition (shown next the gangway) in position there would be convenient corners both for roots and the prepared food.

The stable has three stalls, the cowshed has accommodation for seven cows or bullocks (whichever may be wished), and both are fitted with mangers and stall divisions, such as are described in subsequent pages of this article, and have direct communication with the yard. The further accommodation flanks the yard on either side, and comprises a range of three pig pens with meal and boiling-house attached, together with cartshed, shelter shed, and loose box. The whole of the water from roofs is collected in two tanks at the south end of yard.

So much for the accommodation and compactness of plan; and now as to the construction and expense. It is proposed to form the walls and partitions of 4 by 2 in. studs, framed and braced together, and sheeted with 1 in. stout weather boarding, the whole of the outside woodwork tarred or treated with one of the patent wood preservatives. A 9-in. brick pinning 2 ft. high on proper concrete foundations would be provided throughout to make the life of the woodwork as permanent as possible, and this pinning would be carried up 5 ft. in the case of the mixing floor, or 4 ft. 6 in. to form the walls of pig pens. The floor joists to loft would be 9 by 3 in., and at each principal stud, secured to the framing with iron dogs, and supported midway in the span by a beam, which in turn would be supported by the heel posts of divisions in cowshed and stable carried up. With the flooring of 1½-in. grooved and tongued boarding this floor would then support any weight likely to be put upon it.

The principal economy must be effected in the roof. Except for that over the two-story block, which would be a quarter-pitch span, with 5-by-2-in. ties and good strong wind braces at either end, the rest of the roofs would be simply constructed with 5-by-2-in. rafters lying across from plate to plate, with a very slight fall, and 2-ft. centres, this measurement applying to the rafters throughout. If the rafters are carried over the plates at head and foot a distance of 3 in., and finished with deep facias so as to thoroughly keep out the weather, and any filling above the plate omitted, a very simple but efficient system of ventilation will be provided. A considerable saving is effected also by this mode of roof construction, only one length of guttering to each range being necessary.

It must be remembered, however, that with this form of construction the thrust of the roof, though slight with such a flat pitch, is yet all in one direction, and unless the outside walls are of brick or formed with posts let into the ground, it would not be safe with a long range, where there are no partitions to form a cross brace, unless bracing of some other sort was provided, such as carrying up the divisions in stockyards and bracing from them. For a roofing material 'Ruberoid', or one of the other economical and effective materials, is proposed, which, whilst cheaper than galvanized iron, have the further advantage that they do not subject the buildings to the same extremes of heat and cold, nor cause the annoyance of condensation. But whatever material is employed, to ensure real comfort in the sheds, ⅝-in. boarding on top of the rafters should be provided, and the buildings may then be fairly termed permanent structures.

The cost of this building, exactly as shown on the drawings, with stall fittings, concrete floors, &c., complete, would be £300, which goes far to prove that the cheapness in construction aimed at has been attained, as it works out at but little more than 1¾*d.* per foot cube. Of course even this estimate could be reduced if galvanized iron was employed for the roof, without boarding underneath, this latter being worth £17, 10*s.* in the present case.

Food Department.—This block, which contains the straw barn, granary, cake, chaff, and root stores, together with the mixing floor, is generally a two-storied building stretching east and west, with the stockyards and shed grouped and sheltered under it on the south, and the stackyard on the north. The food factory thus comes in its most convenient position, between the food to be consumed and the consumer.

The straw barn need not now be of the size of the old threshing barns, but only commodious enough to store about one day's threshing, and easy of access to the chaff-cutter and for obtaining litter to be used about the buildings. It should be carried up the whole height of the two stories, and have large doors 12 or 14 ft. high, and sufficiently wide to admit of loaded wagons passing in or out. At the blank end, next the stackyard, and high up beneath the eaves, should be placed doors for passing the threshed straw through, which, if they are to admit the elevator, must be at least 5 ft. wide. For the floor of this building, wood is very expensive, and liable to harbour dirt and vermin, and there can be little doubt that the cheapest

efficient paving is cement concrete, when it is made in a proper manner, of good materials and finished in its 'green' state.

The mixing floor serves for preparing in bulk the pulped roots, chaff, cake, and meal to be served to the cattle, and for this purpose should not only be convenient to the cowsheds, but provided with a corner where the various ingredients, ready mixed, may lie for a day or so to induce fermentation and render them more palatable to the stock.

The root house will adjoin the mixing floor, and with only a dwarf wall about 4 ft. high intervening, the roots may be served direct into the pulper, which stands just inside the mixing floor. It will be very evident that the root house must have blank walls opposite the doors, against which to stack the roots, and both these departments should have wide, double doors, so that carts may back right in, in the one case to dump roots, and in the other to load up the ready mixed food when required for outlying stock about the farm. It will be well also that these doors should be in two heights, the upper half can then be thrown open for the admission of light and air without wandering stock straying in.

The fodder store is intended for the storage of a considerable quantity of hay or other fodder which may be fed 'long' to the stock, and in continued wet weather it will be found of the greatest advantage, though at all times it will save much time and the spoiling and wasting of much good stuff which the daily visit to the stack entails. On the upper floor (which should not be much less than 9 ft. above ground floor) is placed the chaff house, cake room, and granary, all connected in a direct line for ease of communication and trucking right through, as will be understood from the plans in figs. 1 and 2. Special attention must be paid to making these floors strong enough, on account of the vibration of machinery and the great weight they frequently have to carry. The flooring should be of stout grooved-and-tongued boarding to prevent dust falling through.

The chaff house should be immediately over the mixing floor, and connected with a shoot to same, so that the chaff may be shot upon the floor where required. The end of the chaff house next the barn should be open, or at least have a wide opening, and a cart may then be loaded up under cover with chaff, cake, corn, or meal from the granary as may be required, and in bad weather the material for the chaff-cutter can then be unloaded quite dry on to the floor.

The cake house is placed next the chaff house, so that the mills may be driven from the single shafting which operates the chaff-cutter and pulper. The mills should be elevated to deliver the prepared cake and meal into bins, and from the latter shuttered shoots will deliver to the most convenient spot on mixing floor.

The granary should have strong blank walls against which to store the grain. Any skirting should be in cement, the ends of all joists and the spaces above roof plates filled up solid, and the ceiling not plastered, lest there be any hidden harbour for vermin. The roofing must be perfectly weather-tight and able to withstand driving snow, and the staircase should be provided with a strong handrail to give support to men in carrying up or down heavy loads. If a fall of the ground can be utilized, or if, by banking up, a cart may be drawn up with its tail level with the granary floor, so that everything can be barrowed straight in and all mechanical or other lifting dispensed with, it will be found of the greatest convenience. Plenty of light must be admitted to the whole of this upper floor, as should be the case wherever machinery is used, and the roof is undoubtedly the best place for it to come from.

Where a portable engine is used to work the machinery in the above departments, the shed for same should be provided with grooved wheel tracks to ensure a proper position for the belting. It will also make it much easier to get the engine in and out if both ends of the shed are left open.

Stables.—In cart-horse stables it is very desirable that each horse should be provided with a separate stall, which, if the horse is to lie down, must in no case be less than 6 ft. wide. In oldfashioned stables it is not at all unusual to find all the horses standing together, with no divisions between, but this is very objectionable. It is but seldom, perhaps, that one horse injures another; but it will be found that under such circumstances some of the horses will never lie down, much to the detriment of their working powers, and, what is worse, the stronger horses will prevent the weak from getting their fair share of food. Here, then, is a strong plea for separate stalls; but it will be found that many shrink from what they consider such extravagance, when an attempt to compromise by dividing up for pairs should be made, the divisions having 10 ft. centres. The weak horses can then be put together.

The width of the stables may be arrived at by allowing 2 ft. for manger, 7 ft. 6 in. for standing, 12 in. for gutter, and 5 ft. for passage-way behind. This last measurement must be increased where it is determined to hang the harness on the back wall. If the above measurements are adhered to, and the stalls are made 6 ft. wide, to obtain the 800 cubic feet of air space necessary for each animal, with a flat ceiling at plate level, the ceiling joists will need to be 8 ft. 9 in. high. It is very unusual to find feeding passages behind the mangers in stables, as there is not the same objection to feeding horses from the front that there is with cows; but should it be possible to indulge in this extravagance, there is no doubt that horses would do better with their heads farther from the walls, for then their breath and the dust from the manger would not beat back into their nostrils and eyes.

The doors should be 4 ft. wide and at least 7 ft. 6 in. high, in two heights, and be capable (as should all farm doors) of being hinged right back and there fastened. The windows should be of the hit-and-miss pattern, with glazing over, in the back wall, and only augmented by lights in front of the horses, where, the stable being lofty, the light can be well above the horses'

heads. But best of all, perhaps, is light coming from the back slope of roof, if other efficient ventilation is provided; but unless the roof is pantiled and glass tiles are used, large sheets of glass should be employed, as every joint forms a lodgment for dirt and obstructs the light.

To ensure proper ventilation, one of the best and safest means is still that so commonly adopted by our ancestors of carrying the eaves well over, leaving out all filling between the rafters' feet, and raising every fourth or fifth ridge tile. But where there is a loft over, this scheme is not applicable, and the best plan then is to insert an upcast air inlet to each stall in the front wall about 6 ft. 6 in. from the floor, and form outlet panels in the ceiling close up to the back wall and connect by shafts to ridge ventilators. These shafts may be carried up the slope of the rafters, and thus the usual plan of a central shaft, which is such an obstruction in a loft, is obviated.

For the paving of stables a very hard brick will be required, or the iron-shod feet of the horses will make short work of it. It should be remembered also that the surface must be as impervious to moisture as possible, for not only will litter be economized by the urine passing quickly away, but the atmosphere will become less contaminated. Cement concrete is unsuitable, and the cheapest efficient paving is a hard brick on edge, preferably a Staffordshire blue brick. Grooved granolithic slabs can now be obtained very cheaply, are easy to lay, and make splendid paving; but whatever the paving is, it should not be laid with excessive falls, so that the horse has to continually stand with his hind feet several inches lower than his fore feet. A gentle slope of 1 in. in 40 from manger to gutter will be sufficient. The gutter may be the special dished gutter supplied by the brickmakers, or formed with bull-nosed brick edges and bricks laid flat for the bottom, but if the latter it should be wide enough at the bottom to allow the free passage of a shovel. No gullies should be placed inside the building, but the open channels should be conducted through the outside walls, and deliver into the yards where possible, or, if this cannot be managed, into gullies.

The divisions should be formed with hardwood heel posts firmly bedded in the ground, 1 ft. in front of the gutter and 5 ft. out of the ground, with, it is hardly necessary to add, all the arrises taken off; this should be done to all fittings. Three rails should be tenoned into the heel post and again into the head post, the upper rail rising slightly, and the lowest one kept well off the ground to prevent decay. The boarding should be stout, and in any case not tongued nor grooved into the rails, as this makes the matter of repair difficult at once, but simply nailed on one side of the rails and kept 3 in. above the floor.

Splendid glazed ware or iron mangers may be seen in any manufacturer's list nowadays, and their only drawback is expense. The best construction for a manger is to continue the hardwood chinpiece right through, supported in the centre by a post, to which may be attached the tying-up ring. One half can then be manger, and the other made to form a hayrack by carrying down, from chin rail to rail fixed about 12 in. up from floor, perpendicular staves. The bottom of the rack should either be slatted or sloped up in cement, to prevent hayseed and dust accumulating.

In most small stables the harness is hung on the wall at the back of the stalls, but in all fair-sized stables a fodder and harness room combined should be added, approached from the stable. A small compartment opening out of this, for chaff, is a great convenience, especially if arrangements are made for filling it from outside by a small door high up.

Lofts running over stables, with arrangements for bundling the hay down into overhead racks, are not to be commended. The ventilation to the stable is generally not so good in such cases, and even if the overhead rack is not a faulty arrangement in itself, filling from above, so that all the dust of the loft gets into the horses' eyes and mangers, is evidently wrong. The very ease of the operation, moreover, conduces to wastefulness, enough stuff often being put down at one time to last a week. If, on the other hand, hayracks by the side of the mangers are adopted, and the hay has to be carried separately to each manger, the men are far less likely to be troubled with this spirit of wastefulness.

The stable should in all cases adjoin one of the stockyards, and have a door communicating directly with same, not only for the purpose of turning out the horses when it is so desired, but for the easier and better disposal of the soiled litter. The open channels then can also deliver into yards, when the drainage will be absorbed by the manure being made in them.

COWSHEDS (see also art. on BYRE).—Now that it is the almost universal custom to feed dairy cattle in stalls, much more attention has been paid to their housing, and the local sanitary authorities having become empowered to deal with the question in their respective districts, the cowshed is frequently found to be the 'sweetest' and most carefully considered department in the steading, as it should be.

When the cowshed is to stand independently, there can be no question that the cheapest course is to design it with a double row of stalls under one roof. It will be evident how much cheaper this is than to provide sheds having the same accommodation and designed for single rows of stalls, when it is considered that there are fewer walls, less roof, and less actual area covered, for in a shed of double rows one feeding or dunging passage, as the case may be, is common to both. Occasionally, however, it will be found possible to economically build a shed for single row as a lean-to against some other building. In a double shed, the rows will be best arranged so that the cattle stand head to head, with the feeding passage in the centre. The stockyards naturally flanking the sheds, the manure can then be thrown straight out into them. On the other hand, where the cattle stand tail to tail, with the dunging passage in the centre, the fouled litter has to be bundled all the way down the dunging passage to the doorway, which,

even when reached, is unlikely to be in a suitable position for depositing it. This arrangement also has the disadvantage of having the feeding passages divided, and thus the service from the mixing floor cannot be so direct. So far as space is concerned, however, neither of these arrangements is more economical than the other, as may be deduced from the following figures. The feeding passage should be 3 ft. to 4 ft. in width, the manger will take up 2 ft., the standing 6 ft. 6 in. from manger to edge of gutter, which latter should be 12 in. wide, and the dunging passage at least 4 ft.

To many the above length of standing will appear short, but in practice, unless the cows are unusually large, it will be found ample; for where it is made more, the cow will certainly foul its bed, in which case not only is the litter wasted, but the milking is likely to be carried on under unfavourable conditions, it being very rare to find a milker who will trouble to clean the cow before milking it.

The most common mistake in cowshed construction is the paving of the whole area up to the manger, and giving it a continuous fall from manger to gutter. The whole of the cows' excreta falling behind, there is in the first place no need for it; also, when it is considered how averse a cow is to lying on a slope, and that the best standing is rammed chalk, clay, or cinders, it will readily be agreed that the standing above the heel posts should be level, made of one of the latter substances, and only paved below that point, with a gentle slope to gutter.

Anyone who has observed cows lying on a hillside must have noticed that they invariably lie across the slope, and in a cowshed where the standing is sloped right up to the manger, the cows will be seen standing or lying as far back as the chain allows, vainly trying to get on a more comfortable level. Not only is this poor treatment for the cows, but it is also poor policy, for lying over the gutter with their hind quarters unsupported is likely to bring about abortion. Of course, if by chance a single cow should be chained up in a double stall it will lie across it, close up under the manger, and foul the standing above the paving, but this is a chance not worth reckoning with.

In the paving of cowsheds it would be difficult to improve upon grooved granolithic slabs, for in order to economize litter and keep the sheds 'sweet' it is very necessary for all liquids to pass rapidly to the gutter; but good cement concrete is the cheapest paving that can be satisfactorily used.

The local sanitary authorities nowadays have power to control the construction of cowsheds, and, most wisely, will not allow any covered drains or traps inside the buildings, but insist upon all the channels being open, and conducted directly through the outside walls without impediment of any description. These should deliver into the yards, but where these are not convenient, may deliver over gullies connected to the drains.

A very satisfactory type of gutter for cowsheds is that shown by the section (fig. 5). Here the standing next the gutter is terminated with a stone slab, and the dunging passage, which is all at a lower level, is sloped to the same with a steeper incline as it approaches it. This has many advantages. It makes a platform of the standing, and the dung, falling on a lower level, does not soil the bed, while the litter, falling from the platform, is less liable to choke the channel. It is also easy to clean, conduces to a rapid flow, and is readily detected. Of course, ordinary channels, such as described for stables, may be employed, but the litter always bridges it, making a platform for the dung which will foul the cow, and is not easily seen. Feeding passages should be free of all piers or other obstructions, and may be paved with rammed clay or chalk, unless trolleys are to be employed, when a concrete floor is necessary, with guiding grooves for the wheels, except in those cases where rails are proposed.

In cowsheds it is usual to tie the animals up in pairs, in which case the divisions need to be with 8 ft. centres; 6 in. or even 12 in. less is often given, but this leaves the cows very

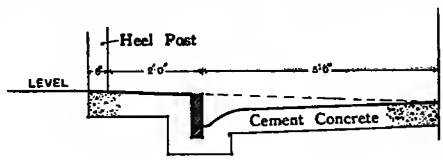


Fig. 5

cramped and also hampers the milkers. The divisions may be constructed in much the same manner as those described for stables, but the heel post is better not so far back, or it will get in the way of the milker. It should certainly be 2 ft. in front of the gutter, and only about 3 ft. 6 in. high, while a rise to 5 ft. at the manger will be sufficient.

For mangers there are manufactured many different forms in glazed ware, which are beautifully clean but rather expensive. If the mangers are to be made of wood, the usual custom is, for ease of construction, to employ an 11-by-1½-in. plank for the sides, with the bottom grooved into same and the two sides well canted. Of course no chinpiece need be provided. There should, however, be a support halfway between the divisions. The food placed in the bins, such as brewers' grains, pulped roots, &c., assisted by the dripping of the animals' noses, keeps them rather damp, and when of wood, the joints should be painted in. A canted fillet is often placed in the angles to enable the food to be cleaned up better. A very good arrangement of the mangers is that each cow should be provided with two bins, which means four bins in each two-stall division, each bin capable of holding a bushel easily, and the bin next division in each case fitted with a ventilated lid to hinge back and fix, with a button against it. This arrangement admits of the two feeds being put in at the same time, and allows of the cows being fed first thing in the morning without delaying the milking. It is also found that some cows will only let their milk down when feeding, so that a bin which can be opened for a short time

will be found convenient. At hay season, too, and harvest, a double bin will allow of the men getting into the fields to help, whereas, with a single bin only, it would have been necessary for them to have been still feeding their animals. The height of the manger should certainly not be more than 1 ft. 9 in. if the cow is to eat in comfort, and it will also experience less difficulty in rising should it be able to get its head over it.

To prevent cows pushing their food out into the feeding passage is a difficult matter, for a roll edge or projection at the back would prevent a large-horned cow from getting at the bottom of the bin. If there is room, the best plan is a canted plank or a ledge with small curb, when the cow will be able to get at what it throws out. Of course this difficulty does not arise where there is no feeding passage, a canted board against the wall throwing the food back; but even in the latter case it should be remembered that the bin must not be quite close up to the wall, or the large-horned cow will be in just as awkward a case.

Nowadays, cows are almost invariably chained up in the stalls, but the chain should not be fixed to the front of the manger, or they may damage each other with their horns and get each other's food. It will be best with a running ring on a stout upright iron bar, fixed on the division near the manger. With quite a short chain, the cow then has perfect freedom when lying down, as the chain drops with it.

The doors to cowsheds should be about 4 ft. wide. If the width is less, a cow forward in calf may be seriously injured, while if it is more, it will probably be equally dangerous, as two cows would try and push in at once. The doors should be in two heights, hung to open out, fold right back, and fasten. Doors must be provided from the sheds into stockyards, and the cows should generally be let out this way, as voiding nearly always takes place immediately after they are loosed, and the roadways are thus not fouled.

The sheds will naturally be built adjoining the yards, and unless these are covered yards with only dwarf walls between them, and the stalls as shown in fig. 6 (p. 29), when the soiled litter may be cast directly out into the yards, it will be found convenient to have low doors somewhere at the ends of the sheds, opening into the yards for that purpose. The space beneath the windows may generally be utilized, but it should be remembered that the manure in the yards is allowed to accumulate, and allowance must be made for it. Ample lighting is of the utmost importance in cowsheds, and the back slope of the roof is the best place for it. Ventilation should be planned so that plenty of fresh air may be introduced without danger of draught, and foul air extracted at the ridge.

Provision for calves should be made in conjunction with the cowsheds. Frequently a space at the end of the range of stalls is partitioned off for this purpose. Calves, however, are very liable to scouring, and great care must be taken to ensure a dry bed for them. If the site is dry, they may do all right on a well-drained floor, but it is best to provide a stout, slatted floor, with 1½-in. spaces, and a dished and drained floor beneath—all the voidings will then pass through and keep the bed dry. The slatted floor must be made in sections, so as to be easily removable for cleaning purposes. Calving boxes should have an area of at least 150 sq. ft., and, if drained, the floor should but slightly fall all one way to a gutter close up against one of the walls. No other gutter or irregularity of the floor must be allowed, and a rammed chalk floor is preferable. The angles may have racks and mangers fitted across them, and the door should be in two heights. The bull house should be made entirely independent by having its partition walls carried right up, and should have direct communication with one of the stockyards. Mention must be made of cattle boxes for fatting beasts. Now that early maturity is aimed at by every breeder, their use has become very common. Each box should have an area of 90 to 100 sq. ft. It is usual to allow the manure to accumulate during the whole period of fatting, the beasts rising with it, the average increase of depth being 9 in. a month. It will be evident, therefore, that the trough will have to be made movable, and the best way is for it to work in grooves on either partition, with adjustable bearers, and sockets for their reception at intervals of 9 in. Loose mangers, slung on chains, are employed for the same purpose, but they are not so suitable. A good plan is to design these boxes in ranges, divided by gate-like divisions working in grooves on either wall and capable of rising with the manure, and entirely removable at will. The end box may then be fitted with wide doors, and the divisions being removed, a cart can be backed right in and clear the manure from the whole range most expeditiously. This system has the further advantage that, should the boxes not be required for fatting purposes, the divisions can be taken away and the shed used as a covered yard for young stock or any other purpose.

Piggeries.—Until recent years the almost invariable form taken by this adjunct of the steading was the covered sty and run. But to the practical designer of to-day it presents the serious objection that, when out of use, it is quite unsuitable for the housing of any other form of stock; and as pig-keeping is likely to be intermittent on any holding, not only through the personal practice of individual tenants, but also for various reasons—such as dear feeding-stuffs, low price of pork, or even fever regulations—covered pens, equally suitable for the housing of other forms of stock, have become the more usual type. These pens, or boxes, should have an area of 80 to 90 sq. ft., with one or two perhaps a little larger for use as farrowing pens, and separated by walls about 4 ft. 6 in. high. If possible the range of pens should adjoin one of the yards, as shown in all the plans accompanying this article, when the front wall may be of similar height to the division walls, but with a door giving access to the yard. The manure and drainage from the pens can then be easily and profitably disposed of in the yard. The space over the front wall should be fitted with a shutter hinged to the roof plate, which,

except in bad weather, can be fastened back to the tie-beams.

If a feeding passage can be provided at the back of the row of pens, leading to a meal and boiler house at the end of the range, it will make a compact arrangement. A device saving a lot of labour is to place the feeding-troughs between the pen and feeding passage, with a swinging shutter hung centrally above them, so that it may be bolted on the pen side in filling the troughs, and then swung back and bolted next the passage, throwing the whole into the pen. This is made in iron by every manufacturer of agricultural fittings, but may be made of wood and just as efficiently by any carpenter, though it should be remembered that the shutter will have to be very strong. A guard rail should be fixed 6 in. out from wall and 10 in. from the floor, round all farrowing pens, to prevent the sow lying on her young. The best floor is cement concrete, with a few grooves in same, sloping towards yard, to carry off quickly the large amount of liquid voided by these animals.

The old form of sty and run is so familiar that it is not necessary to give any details of it, but where it is adhered to, care should be taken to form the sleeping place at a higher level than the run, to ensure its being dry, whilst, except for the step into it, which should be of stone or concrete, the floor may be of rammed chalk, which will be warmer than anything else. The outer court, however, must be paved, and provided with good drainage. The boiling-house should provide space for several meal and swill tubs, and have a good-sized copper and furnace fixed in it. If the farm is a large one and much rearing of stock takes place, a small open fireplace might be added, which would greatly conduce to the comfort of men sitting up on cold nights.

Yards.—It is only in comparatively recent times that the practice of completely covering in these important adjuncts of the steading has become at all common, and now, amongst practical men, it would probably be difficult to find tenants who would not wish to avail themselves of it. Apart from the fact that warmth, in the case of stock, takes the place of a certain amount of food, there is the latter-day recommendation that, with quick maturity aimed at in all cases of stock, high feeding, with a general use of cake and corn, has been adopted, and considering the high manurial value of the excreta of animals so fed, it is most unwise to let it waste in rain-washed yards. In confirmation of this it need only be stated that the average annual amount of manure produced by cattle is computed to be 16 tons per head, which amount, lying in an open yard 18 in. thick, and under normal conditions of rainfall, would be drenched by rain at the rate of 24 tons per annum.

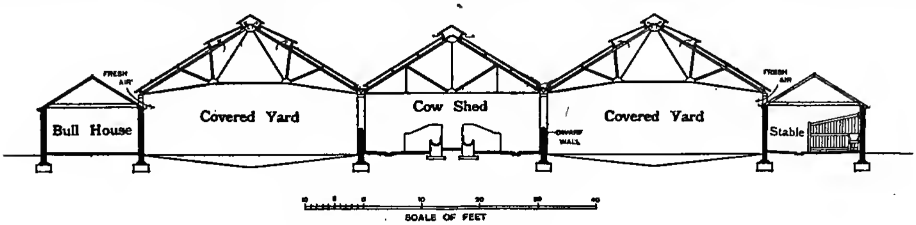


Fig. 6

One of the few disadvantages urged against covered yards is the thinness of coat on young stock resulting from their use, and the great care which has to be exercised in turning them out to pasture in the spring. For this reason, and for the reason that in the eastern counties it is the almost invariable custom to turn the cart horses out at night into an open yard, there will occasionally be found those who wish for an open yard. When this is so, the whole of the eaves to the adjoining buildings should be guttered and spouted, and deep shelter sheds provided. It is a common mistake to make these latter too shallow, so that little protection is afforded the animals. The minimum depth should be 14 ft., but 2 or 3 ft. may be added with advantage. The eaves should also be as low as possible, to admit of the accumulation of manure, and yet allow the horses to pass beneath. About 8 ft. is usual.

The construction of covered yards is best explained by the accompanying illustration (fig. 6), which is a section through the bull house, cowshed, and stable of plan shown by fig. 1 (p. 20). It will be seen that piers are taken up at intervals, above the eaves of lower buildings, to carry the roof principals. Fresh air is thus admitted on either side at eaves' level, and ventilation is freely provided in roof. Of course timber construction for the roofs may be adopted, but where the span is so wide, steel is cheaper and lighter, and under no circumstances should supports be introduced in the middle of yards. In fact the piers themselves may, in some cases, be economically replaced by steel stanchions bedded in concrete. The gable ends should be covered in to the plate level, and wind braces should be provided to roof. In covered yards it is very necessary for the making of good manure that the drainage from the adjoining sheds should be conducted into them, not only that the drainage may be put to its best use, but because without it, there will not be enough liquid in the yards for the litter to absorb.

There should be an allowance of 150 sq. ft. per beast in the yards, and a good water supply to which the stock can have access at any time. For this purpose, where there is no pressure, it is well to build tanks in the boundary wall of yards, into which the rainwater caught from

the roofs may be conducted, and connection then made to troughs beneath them. Under no circumstances should the cattle be allowed to drink out of the main tank, for if they should, the tank will quickly get fouled, the water made unfit for the cattle to drink, and a likely contributor to the spread of disease, whilst the tank will most improbably, or at least infrequently, be cleaned out. For the same reason it is most unwise to have the troughs made self-supplying, but with a tap over them they may be quickly filled and under constant inspection. Safety overflows should be provided to all tanks.

The gates of all yards should be 10 ft. wide, and hung to open outwards and fall right back and fasten. When there are gates between two yards, allowance must of course be made for them to clear the manure as it rises. One plan is to have two sets of hooks, one 2 ft. higher than the other; but the commonest plan, and the only one feasible if the yards are to be used for pigs, is to provide what are generally termed 'slips', constructed like miniature gates, about 2 ft. 3 in. high, and which work up and down in grooves formed in the gateposts, and are entirely removable when not required. Palings make very bad fences between or around yards, but should they be necessary on the score of economy, the pales should be placed close together, with square tops, or an animal may get hung up and seriously injured. For the same reason the top rails of gates should be kept close enough together to prevent animals ever putting their heads through.

Cart Shedding and Miscellaneous.—It is evident that the amount of accommodation required for carts, &c., will be governed by the amount of arable land as compared with the pasturage on the holding, the shedding increasing proportionately with the excess of arable land. Cart sheds should, if possible, be placed near the stables and have a north-east aspect, with the openings not less than 9 ft. wide in the clear, and the height to the eaves not more than 8 ft., to keep out the weather as much as possible. As to depth, a single wagon or two tumbrils will require 20 ft. to properly protect them, but 30 ft. will accommodate two wagons or four tumbrils. Knocking stumps should protect the posts at entrance, and a guard rail should be placed in front of the back wall to prevent carts being backed too far.

An implement shed for the more expensive implements is necessary, and should have an opening 10 ft. wide with doors to lock up, and be provided either with windows or a light in the roof. A tool house should be provided in conjunction with this department, and besides allowing plenty of space for storing rakes, forks, ropes, &c., should be fitted with a work bench along one side beneath a window. The door should be fitted with a lock.

Dutch barns or hay sheds (see Hay and Sheaf Sheds) have become very popular of recent years, and deservedly so, for their cost of construction is so small, while their usefulness is great. Not only is the cost of thatching and the use of tilts avoided by their use, but in wet weather loaded wagons may be sheltered beneath them, whilst it is also claimed that ricks dry much better under them owing to the free passage of air over the top. The wagons draw between the bays, so that these should be not less than 12 ft. in width, but with iron construction they may profitably be made 14 ft., and as cost is the only thing which governs the length that they may usefully be made, any multiple of that figure will do. To admit of topped-up wagons passing through they should be 14 ft. high to the under side of plate, and to afford protection to a load they should be 20 ft. wide. As much space as possible should be left in the roof, and the whole fitted with gutters and down spouting, whilst the gables above plate level should be closed in. Strutting to the plate between the posts is liable to be a hindrance in passing a big load, and the struts therefore should be as little in evidence as possible. If, however, the whole construction is of iron, it will probably be sufficient to ensure rigidity if the two end bays are cross-strutted from ground to plate, at both sides and ends, for as there is no necessity for passing wagons through the two end bays, the usefulness of the barn will not be impaired. It is most important with these buildings that the roof should be stiffened by diagonal wind braces.

A few good-sized loose boxes should be provided for calving and foaling, also to serve as sick-boxes. The doors should open in two heights, and plenty of light should be admitted. Unless a special slaughter-house is provided, which can hardly be necessary in the majority of farms, one of these boxes may be fitted with a beam, capable of sustaining a ton, for slinging an injured animal or slaughtering those past veterinary aid.

Few other adjuncts of the modern steading remain to be noticed. In some instances a business office and blacksmith's shop are included, but the former can scarcely be needed except at a home farm, where the agent may not live close at hand, and the latter only in the case of very large holdings. No fowl houses have been shown on the plans accompanying this article, and it is not proposed to enter into the details of them, for there can be no doubt that the permanent fowl house has been superseded by the portable one, wherever fowl-keeping is profitably and satisfactorily carried on. [H. M. C.]

Buildings for a Dairy Farm where Cheese is made.—Fig. 7 shows the arrangement of a steading designed for a dairy farm of about 500 acres of medium land, where cheese is the staple product. The chief consideration in arranging such a steading is the necessity of minimizing labour at the homestead, and at the same time satisfying modern sanitary requirements. The hay and straw sheds, root house, and food stores are placed convenient to the cow byres. The grain crop is stored in a large shed communicating directly with the threshing barn, while the straw house is in close proximity to the cow houses. The granaries are situated over the barns. The motive power for the threshing and food-preparing machines is supplied from

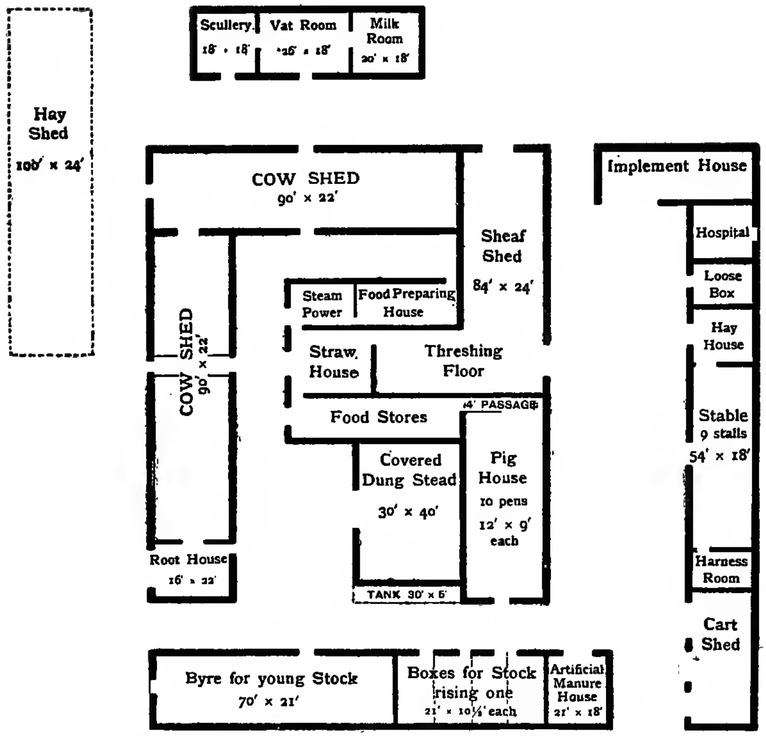


Fig. 7.—Arrangement of Buildings for Dairy Farm producing Cheese

a steam engine. The same engine and boiler may be utilized for the steaming of foods, and in driving the vacuum pump of the milking machine where such is employed.

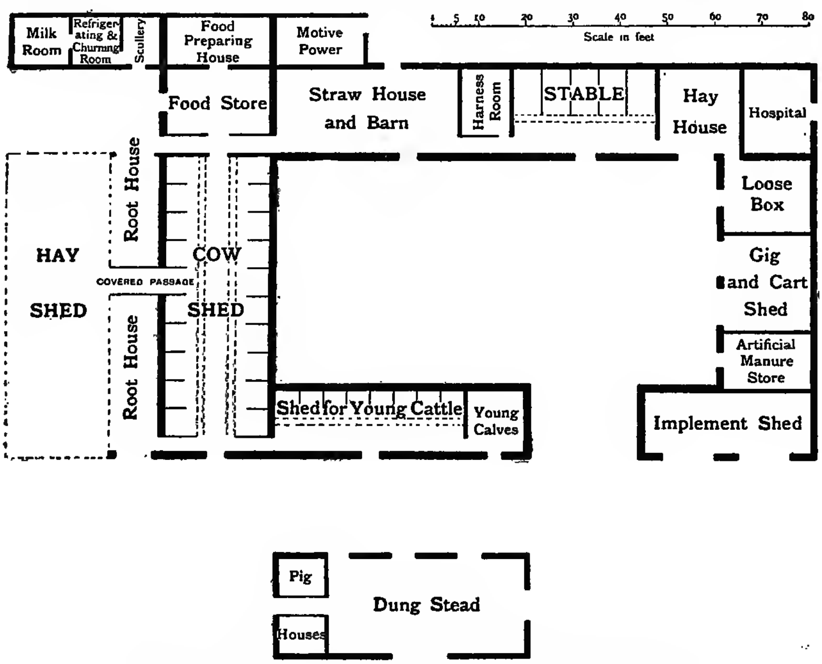


Fig. 8.—Arrangement of Buildings for Milk-selling Farm of 150 to 200 acres

The byres have outer walls along the entire length, so that thorough ventilation is possible. The dairy houses are safely removed from the proximity of piggeries, dungstead, and food houses and other sources of undesirable odours, and are situated to the north of the steading. Yet they are conveniently reached from the cow byres without any direct internal communication. Cheese ripening or curing accommodation is provided over the milk and vat rooms. This for a large dairy should consist of two distinct rooms fitted with turning shelves and with heating apparatus—hot water or steam pipes. [W. S.]

Buildings for Dairy Farm where the Milk is sold.—Fig. 8 represents a steading suitable for a milk-selling farm of from 150 to 200 ac. in extent.

It will be seen at a glance that the various buildings are so arranged relative to each other that the work of feeding, tending, &c., is greatly lightened. The straw barn communicates directly with a five-stalled stable, and two byres (stalled for 38 cows and 16 young cattle respectively). The hay shed is situated on the west side of the buildings, and communicates directly with the byres, and though it is a considerable distance from the stable, this seeming disadvantage has been remedied by providing a hay house capable of holding a considerable quantity of fodder. This arrangement of straw barn and hay shed not only greatly reduces the work of foddering, but prevents the inevitable waste which occurs when fodder has to be carried from place to place in the open. Root houses are provided between the hay shed and cow byre, and are therefore very convenient both for cows and young cattle. The food-preparing house is on the north side of the building, and is only separated from the byre by the food store. The motive power is in close proximity, and can be utilized for 'bruising', 'grinding', 'chaffing', &c.

The milk room (which need not be very large on a milk-selling farm) stands at the north-west corner of the building. It is convenient to the byre but yet entirely isolated from it, and accordingly fulfils all sanitary requirements. The buttermaking and refrigerating room adjoins the milk room, and in it a plentiful supply of cold water for refrigerating purposes is necessary. A scullery, which should contain hot and cold water, is also provided.

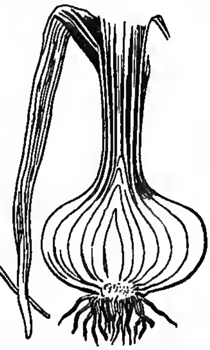
Other necessary buildings, including a loose box, cart shed, implement house, manure store, &c., are also shown in the plan, and arranged as conveniently as possible. The dungstead, which may be either open or covered, is on the south side of the building and quite convenient to the byres. Only two pig houses are shown, but where the milk is sold these would be ample.

One great recommendation for the adoption of this kind of plan is the facility with which it can be extended to suit almost any size of holding. The fact also that the work of feeding has been made as easy as possible, and can all be done under cover, is another point greatly in its favour. [W. G. R. P.]

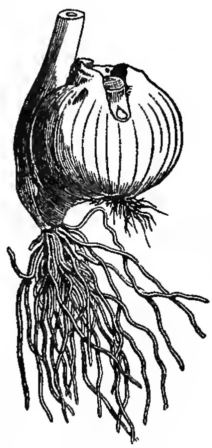
Buisting. See Branding.

Bulbs.—A large number of plants are characterized by the possession of an abbreviated stem more or less clothed with scales (modified leaves or leaf-stalks), enclosing a bud or central shoot, this structure being what is termed a *bulb*. In the Lily the bulb is coated with overlapping fleshy scales, whilst in the Onion the bulb is formed of the sheathing bases of the leaf folded tightly over each other in many

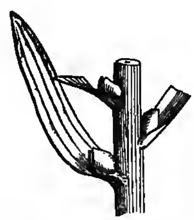
Lily—Scaly Bulb



Onion—Tunicated Bulb



Colchicum—Corm



Bulb-bearing Lily—portion of Stem

layers. In the Crocus the underground stock is made up of two or three solid bulbs, the uppermost one bearing the buds. Correctly speaking, such a growth is a *corm* and not a bulb, although the top layer or bud is formed exactly as in the Narcissus, and the lower solid layers are analogous to the disk-like base of bulbs proper. The fleshy scales of bulbs are often employed for the purpose of propagation. In Lilium, for instance, the scales, if separated and placed in sand, soon form buds at the base which ultimately become bulbs. In like manner the scales of Hyacinths, Tulips, and Crinums will develop buds if the disk at the base is carefully removed with a sharp knife, and the scales are cut across several times and placed in moist sand in a little warmth.

Bulbs are largely used in decorative gardening. In Holland they are grown in enormous

quantities, forming a staple industry, and in Japan also certain bulbous plants are grown agriculturally, millions of lily bulbs alone being annually exported from that country, principally to Europe and the United States. The peculiar structure of a bulb, evidently intended to enable the plant to withstand the vicissitudes of drought, &c., favours its transportation, and it is possible to keep bulbs in a condition of dryness for months without in any way affecting their vitality. With few exceptions all bulbous plants develop leaves, and in some cases stems and flowers, as well as seeds, within the year. It is therefore convenient to plant bulbs in the ground in late autumn or early spring, which will flower in a few weeks or months and then go to rest, so that they can be dug up and kept in a dry place until the return of planting time. Thus such bulbs as Daffodils, Tulips, Hyacinths, Crocuses, Gladiolus, Lilies, and Fritillarias may be used for flower-garden purposes during a portion of the year, and whilst at rest be kept in a dry shed, allowing the ground to be occupied with other plants. Generally, however, it is advisable to plant all bulbs in positions where they can be left undisturbed. Once established, they practically look after themselves, and most of them may be planted deep enough to admit of other plants being grown in the soil above them. This is the best arrangement for hardy bulbs. In the wild garden, for instance, many hardy bulbs are more at home than in the border or flower bed. All the species and varieties of Narcissus are seen at their best, and certainly grow most vigorously, when they are planted irregularly in the grass under trees and in open plantations, orchards, &c. In fact, many varieties of Narcissi which have entirely disappeared from gardens have been rediscovered in old orchards and meadows. Snowdrops, Crocuses, some of the Liliums and Gladioli also thrive under these conditions. When once the nature of bulbous plants is properly understood, their management is easy. Dutch Tulips, Hyacinths, Crocuses, Muscaris, Snowdrops, and to some extent Daffodils are largely employed in formal gardening, the effects they produce in spring being greatly appreciated; still, they look happiest when they are planted and grouped in a natural way, as such things are to be seen growing in woods, copses, and meadows, and once established where the conditions are favourable, they increase and multiply often to a most extraordinary degree. [W. W.]

Bull, Burnt.—The technical name for this disease in the bull is gonorrhœa. It is an affection of the male organ of generation involving the surrounding sheath. When first noticed there is usually a profuse discharge of thick pus, and evident pain is observed when the animal is passing urine, which never comes away in a full stream, but rather in jets. A certain amount of fever is present. The whole sheath is swollen, hot, and tender to touch, and internally becomes ulcerated, and abscesses may form in it. The condition is attributable to excessive service and extreme indulgence, and is most often seen in highly fed though otherwise neglected animals. If remedial measures are not adopted the disease will spread, and fungus growths will appear which may necessitate the amputation of the organ.

Treatment.—Thoroughly cleanse the affected parts with soap and warm water, open any abscesses that may be present; inject up the sheath a 1-per-cent warm solution of chinosol three times a day after first fomenting well with warm water. Give the animal internally magnesium sulphate 1 lb. Although considerable sensual excitement is manifested in both male and female animals affected with this disorder, they must never be indulged, since this only aggravates the case. [H. L.]

Bull, Choice and Characters of.—The choice of a bull for the improvement of a herd is of supreme importance. It is frequently stated that 'the bull is half the herd', because he exerts an influence on the progeny equal to the sum of the influence exerted by all the females; but that statement assumes that the cows are equal in merit and prepotency to the bull, a condition of excellence that rarely exists. That the bull is half the herd is therefore in general an understatement, for as a rule he will be superior to the cows with which he is mated. The magnitude of the sire's influence is abundantly proved in the annals of all the herds of live stock. Comet and Hubback in the history of the Shorthorns have their corresponding types in Old Jock of the Aberdeen-Angus and Mosstrooper of the Galloways. The type of bull to be selected is determined by the purpose for which he is required. He may be for service in a pure-bred herd for the breeding of the most fashionable strain, for a pure-bred herd of commercial cattle, or for crossing; but so much depends on the character of the females with which he is mated, that it is difficult to lay down rules for guidance. In all cases, however, the bull should be pedigreed, and for use in a fashionable herd should have a lineage containing a large number of animals of high merit, especially in his near ancestry. If the herd for which he is intended is line-bred, special care must be taken in selection, and he must almost of necessity be line-bred also, or in all probability he will be inferior in prepotency to the cows.

In addition to his individual merit and adherence to type, he should be specially strong in the point or points in which the females are deficient or relatively weak. For a commercial herd in process of improvement from common stock, length of pedigree is of less importance than individual merit in general breed type, but as the commercial herd approaches higher excellence, the ancestral record should receive more attention. Bulls of the beef cattle, in addition to showing the authorized points of the breed, should be exceptionally well developed in the back, loins, and thighs, where the most valuable meat is found. The ribs should be well arched, carried well down and far back, and showing no bareness whatever; the skin should be medium in thickness, moving easily to the touch as though well oiled underneath, and covered with fine abundant hair.

All the meaty parts should feel mellow and smooth when handled, and the flank should be full and pendulant.

Bulls for dairy herds should be bred from cows of good milking qualities, as the milking capacity is undoubtedly transmissible through the male, the dairy character of which is generally indicated by well-developed teats. If possible, the bull should be obtained from a herd of which milk records have been kept, and records of the milk production of his dam and granddam should be known.

For crossing or for mating with grade cattle to produce good beef calves the bull should be selected chiefly for his size, masculinity, constitution, and richness of flesh. An expensive bull for use on grade or common country cattle would be unprofitable, and hence pedigree, combined with high individual merit, is practically unattainable for crossing purposes. [R. B. G.]

Bullace Tree. See PRUNUS.

Bull-baiting.—The sport of bull-baiting, so popular in the time of Queen Elizabeth and later, is now illegal in the United Kingdom, but has left us the breed of dogs known as the Bulldog (see next art.). The bulls used in the ring in Latin countries are of a particularly pugnacious breed, and individuals or strains remarkable for ferocity are highly valued, and bred with a special view to the cruel sport to be witnessed on great occasions in the few countries where public opinion has not been clearly expressed against it. [H. L.]

Bulldog, The.—That the national dog of England is now a very different animal from what he was, even a generation ago, is a fact which no middle-aged man who possesses a knowledge of the breed is at all likely to dispute. The dogs which our fathers knew, moreover, were of a totally different character to the *Canis molossus* or the Bandogge, from which the Bulldog has undoubtedly sprung. The former was of a very much larger size than the modern dog, and was regarded principally as a protector of his owner's life and property from the lawless bands which used to devastate the country, and also from the attacks of wild animals.

Bulldog

As times advanced, the breed, such as it was, became more associated with what was regarded as sport in those remote periods, and known as the dogges of the Botcherie, the ancestors of the present breed, were used for fighting other animals and each other as their owners desired.

The advance of civilization in due course accomplished the extinction of the wolves and other menaces to the safety of life and property in the country, and hence the utility of these dogs became depreciated, the result being that they gradually were abandoned by the better class of dog-owner, and came wholly under the control of those who devoted them to purposes which, though legitimate enough a century ago, are not regarded with favour by the present generation.

It may here be repeated that the Bulldog of the period last referred to was a totally different animal to the modern representatives of the breed. He not only was a far heavier dog, being not much smaller than the modern mastiff, a breed to which he was closely allied through the ancient *Canis molossus*, but he was higher on the leg and considerably longer in the muzzle. There are, however, many points in common between the Bulldogs of the past and present, both possessing the same great length of skull, the huge nose and powerful jaws, with the deep flews, now known as chop, all of which are so characteristic of the breed.

From being a useful guard to property, the Bulldog developed entirely into a fighting race, and hence no doubt the evil repute into which he fell. His most evil propensities were developed by his breeders, whose only object was to produce a canine gladiator who could bait a bull successfully, and who was brave enough to face a lion or a bear if called upon—as there are accounts forthcoming that some Bulldogs were.

It may here be remarked that the so-called sport of bull-baiting, which was fostered in this country until well on towards the middle of last century, consisted of owners slipping their dogs in turn at a bull which was tethered to a post, the object being for the dog to pin his opponent by the nose and bring him to the ground. It is worthy of special reference, therefore, that the propensity for attacking the head of another animal is a characteristic which is still attached to the modern Bulldog. It has doubtless been inherited from his ancestors, and it is remarkable that it has been so, as the formation of the modern dog is very different to that of the old one, and his disposition has wonderfully improved.

Perhaps at this point an effort may be made, in justice to the Bulldog of the day, to disabuse the minds of the public as regards the ferocity of disposition which those who are unacquainted with him believe that he possesses. As a matter

of fact, the twentieth-century Bulldog is little more than a genial-dispositioned lapdog. Occasionally, of course—but cases are very rare—a bad-tempered one is to be found, as in every other breed, but speaking for ninety per cent of the Bulldogs now in existence it may be truthfully remarked that they are remarkably slow to anger, and will endure more teasing from children than most dogs will.

The chief characteristics of the Bulldog are an enormous skull, very square in shape and high at the temples, a large *retroussé* nose, a wide, projecting under jaw, and heavy flews or 'chop'. There is also a curiously developed hollow between the eyes which is known as the 'stop', and the eyes, which should be large and dark in colour, should be wide apart. A great point for breeders to secure in connection with the ears is that they should be small and set on the corners of the skull, so as to increase the squareness of its appearance, the correct shape of ear being the 'rose' formation which folds inwards at the back, the front edge falling backwards so as to show the inside burr.

The neck should be rather short, very massive, and carry a double dewlap, and the more loose skin and wrinkles that the head and neck show, the more the possessor is admired. The shoulders should slope, but points of more importance are a wide, deep chest, and very powerful, short legs adorned by a large quantity of muscle on the outside, so much indeed that the limbs often appear to be bowed, though the bones are perfectly straight. The back of the Bulldog is short—the shorter the better—and as it rises considerably at the loins and falls away again towards the tail, it produces the 'roach' or 'wheel' appearance which is regarded as one of the chief beauties of the breed. The tail should be short, and the hind legs rather straight both at the stifle joints and hocks, and the feet as round as possible, the front ones being more so than the others. As regards colours it may be observed that black markings are decidedly objectionable; whilst of weights it may be said that Bulldogs scale anything from 24 lb. to 60 lb. or over.

The interests of the Bulldog are protected by many clubs, conspicuous amongst which may be mentioned the Bulldog Club, the London Bulldog Society, and the British Bulldog Club. [V. S.]

Bullfinch (*Pyrrhula europæa*).—This handsome resident member of the Finch family is distinguished by its black head, brick-red breast, and white rump, brown taking the place of red in the female. The shallow cup-shaped nest is built in low trees and bushes, and made up of a basis of twigs lined by fibre of various kinds, and sometimes feathers. The four to six eggs exhibit brown streaks and blotches on a greenish-blue ground. Bullfinches are fond of wooded country and prefer the higher ground. The Bullfinch is exclusively a vegetarian, and, unlike the majority of finches, rears its young on seeds, not insects and the like. The seeds selected are of many kinds, and include those of forest trees and those embedded in various berries. For half the year, autumn to March, the food consists mainly of buds, those of fruit trees included. The bird is not very harmful to agriculture proper, but its habit of destroying buds and seeds (including germinating ones) makes it a pest to forestry, and still more to the gardener and fruit-grower. Except on sentimental grounds, no good word can be said in its favour, so far as our present knowledge goes. [J. R. A. D.]

Bullimong, a mixture of oats, peas, and mixed grains, sown together as a forage crop. The custom is confined to certain limited areas, and the word is almost obsolete save in those districts. [H. L.]

Bullock.—Bull calves which are not intended for stock purposes, and are not fed for veal, are castrated and reared for the butcher. After castration they are known as bullock calves, and later as year-old bullocks, &c. For an account of the rearing and feeding of bullocks, see the arts. CATTLE, FEEDING AND MANAGEMENT OF STORE; CATTLE, FATTENING OF; &c.

Bulls, Dangerous. See ANIMALS, LAWS REGARDING.

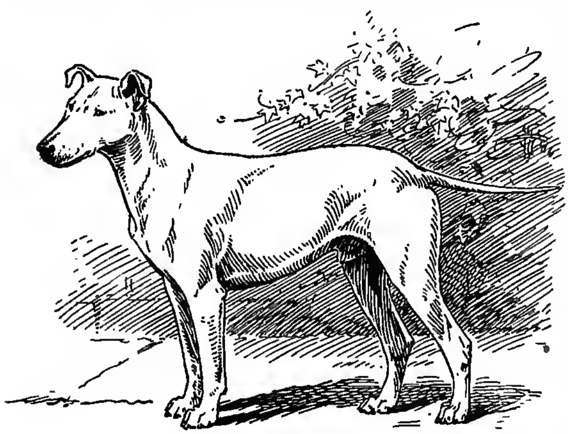
Bull Terrier, The.—This most engaging but unfortunately unappreciated breed is by comparison with many other varieties a modern production. That is to say, his existence as a recognized variety does not date back further than the last century, and not, to speak truthfully, to quite the beginning of that. The Bull Terrier, moreover, exists under the misfortune of having been associated during most of his existence with a class of human being that can scarcely be regarded as having exercised a beneficial influence over him, as the dog was mainly produced by the supporters of dog-fighting, and hence, not so many years ago, to be in possession of a Bull Terrier was tantamount to admitting that one was a supporter of a particularly objectionable form of recreation, which under no possibility could be regarded as a branch of sport.

A generation ago, however, the position of the Bull Terrier improved materially, a better class of dog-lover began to take an interest in him, and his numbers increased and multiplied accordingly. A little later on, however, misfortune overtook the breed again, as regulations were passed which prohibited the cropping of bull terriers' ears, which practice, rightly or wrongly, the majority of his supporters regarded as a necessary protection to him from the attacks of other combative members of his race, and since then he has gradually lost ground in the estimation of breeders.

The origin of the Bull Terrier was undoubtedly a Bulldog cross upon a terrier, the latter in all probability being the old English variety which existed a century or more ago, and which formed the foundation stock from which other varieties have probably sprung. The object which prompted his breeders to produce him is not difficult to see, as they were doubtless anxious to obtain a dog for fighting purposes which would combine the pluck of the Bulldog with the punishing power and the activity of the terrier family. The Bulldog of a hundred

years ago was rapidly becoming useless as a fighting dog, being slower in his movements and more cumbersome than he was formerly, whilst the tenacity with which he holds on when his teeth have once met in his adversary was found to be a disadvantage in the pit. Hence the production of the Bull Terrier.

Originally, no doubt he was a very different sort of animal to the level-headed, tight-lipped, white-coated specimens of the breed which are to be seen at dog shows. Indeed he is still to be found in fairly large numbers in the Black Country, of a very similar appearance to the animals portrayed in old pictures of representative dogs of many years ago. These favoured the Bulldog far more in appearance than the terrier, and in fact corresponded very closely to the Bull *and* terrier of the modern Potteries and Black Country. The latter animals are rarely of the white colour, which is the only one that is recognized by the judges at dog shows, but for the most part resemble their ancestors the Bulldogs of the past, and thereby appear as brindles, reds, fawns, and pied specimens of such. They are also much thicker in the head than the show dog is, whilst many of them are underhung, a fault which would lead to the disqualification of the latter.



Bull Terrier

Beyond all doubt the Bull Terrier suffers from an infirmity of temper which has earned for him a worse name than he would otherwise have possessed; but if kept properly under control from puppyhood, and provided that he is not encouraged to fight, the breed is not so unreasonably savage as it is believed to be by people who have no experience of it. They unquestionably possess intelligence beyond the ordinary, and are most companionable and active dogs, but it must be confessed that at best their tempers are apt to be uncertain, and hence they cannot be recommended as a general-purpose dog.

The head of a Bull Terrier should be flat, long, and lean, the muzzle showing no signs of weakness, but on the contrary being of exceptional strength. The jaws must be level, an undershot mouth being regarded as a very serious fault, and the skin of the lips should be tightly drawn over the teeth. The eyes are small, more of the almond shape than round, very dark in colour, and should be set obliquely, whilst the cheeks should show no bumps at the base of the jaws, but be perfectly smooth. The neck is rather long, but it is powerful, and should be well set on to nicely sloping shoulders; the chest is wide and the body deep behind the shoulders, whilst the body is well ribbed up, the back short and flat, and the hind quarters well supplied with muscle.

The front legs are of a fair length and heavy in bone; they must show no signs of turning outwards at the elbow, but be set on well under the body and be absolutely straight, the feet being rather large, round in shape, and compact. The tail should be short and fine, and free from curl, the correct carriage being quite straight; whilst the hind legs have the hocks close to the ground, and these should not be too much bent. The coat is short and rather harsh to the touch, the favourite colour being pure white. On the subject of weight considerable latitude is allowed, as Bull Terriers now scale anything from about 25 lb. to 50 lb. Thirty years ago the usual classification of weights was under 16 lb. and over 30 lb., the middle weights being discouraged, but since then the ideas of breeders have altered. Like most other breeds, the Bull Terrier possesses a club named after him to protect his interests. [V. S.]

Bulrush (*Scirpus lacustris*, L.).—The Bulrush is a perennial herb of the Sedge family, Cyperaceæ, which is frequently found growing in river, lake, and marsh. The stems are round and spongy, sometimes as thick as the thumb, and varying in height from 2 to 8 ft. We all know rush-bottomed chairs; these rush bottoms are made from the stems of the bulrush. The finer bottoms are made from the one-year-old stems, the coarser bottoms from the older stems. [A. N. M'A.]

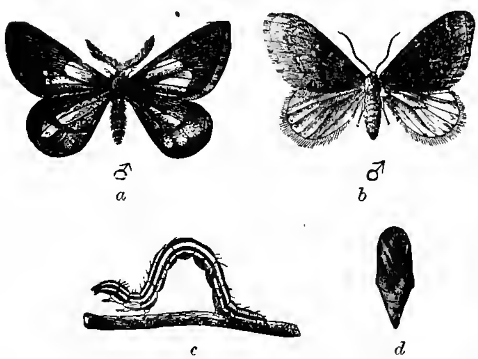
Bunium, the botanical name of the plant known as Earthnut. See EARTHNUT.

Bunt. See TILLETIA.

Buntings.—These small birds are distinguished from finches by a notch in the beak and a knob on the front part of the roof of the mouth. There are a number of native species, of which the chief are the Yellow Bunting or Yellow Ammer (*Emberiza citrinella*), and the Corn Bunting (*E. miliaria*). The former is the commonest form. As the name indicates, the Yellow Ammer is largely yellow in colour, this being the predominant tint of head, throat, and breast, with chestnut streaks. This applies to the male especially, for the female is less yellow, and the streaks on her head are black. The nest is generally to be found close to the ground in a hedge bank, and is built of grass and moss, lined by finer vegetable fibre and horse hair. The four to five eggs exhibit an intricate pattern of spots and streaks of purplish-brown on a white ground. The species affects open country,

though it is fond of the neighbourhood of bushes and coniferous trees. The food of this and other species mainly consists of weed-seeds and insects, though grains of corn are to some extent taken, but apparently only those that lie on the surface of the ground. They are not as a rule dug up or filched. The young (two broods in the year) are fed entirely on insects. The Yellow Ammer—and the same is true for the other buntings—is not of great importance to the cultivator, but is predominatingly beneficial. Having regard to this, and the fact that it is one of the most cheerful and pleasing among our native small birds, it should escape persecution. [J. R. A. D.]

Bupalus piniarius (the Pine Looper Moth), a common and serious pest of the Scotch



Pine Looper Moth (*Bupalus piniarius*)[1]

a, Male; *b*, female; *c*, caterpillar; *d*, pupa.

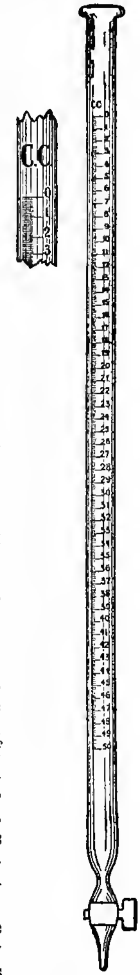
pine, occasionally attacking other conifers also. The moth measures nearly $1\frac{1}{2}$ in. across the extended wings, and is bright-yellow, with dark-brown markings in the male; reddish-brown, with black-brown markings in the female. The yellow-green looper caterpillar has three white lines along the back, and a yellow line along each side. The eggs are laid in June, and the young caterpillars are found in July, principally on trees twenty to forty years old. They are fully grown in October, and pupate on the ground beneath the trees in moss, &c. Complete defoliation is seldom fatal to the trees. *Treatment.*—(1) Shaking down and destroying the caterpillars in August; (2) collecting the chrysalids in winter, or raking the surface soil into heaps and burning; (3) admitting pigs from October to April. Fifty pigs are recommended for 500 acres. [C. W.]

Burdock, a troublesome biennial weed belonging to the nat. ord. Compositæ. It is described under its botanical name ARCTIUM LAPPA.

Burette is an instrument used for delivering accurately measured quantities of any liquid. It consists of a long glass tube of uniform bore, open at one end, and closed at the other by means of a glass stopcock, or of a piece of india-rubber tubing enclosing either a glass bead or stoppered with a metal pinchcock.

[1] From Schlich's Manual of Forestry. By permission.

The open end is generally widened for greater convenience in admitting liquids, the closed end is much narrowed so as to allow of a better control in the delivery of very small quantities of liquid from the instrument.



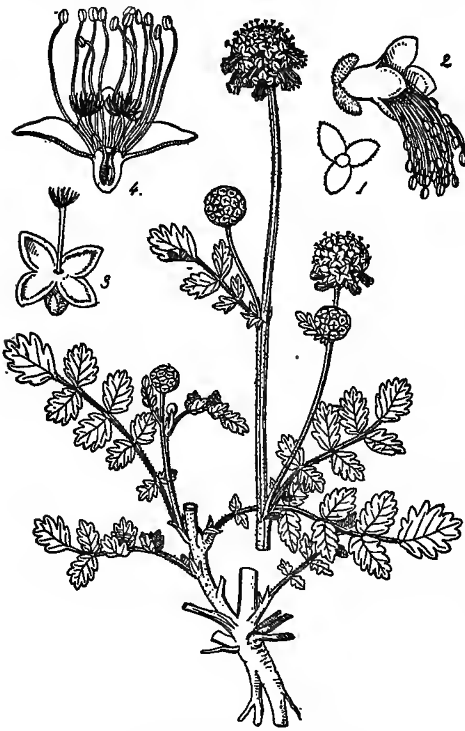
Burette

Burettes are graduated into either $\frac{1}{5}$ or $\frac{1}{10}$ c. cm., and they are made to hold either 20, 50, or 100 c. cm.; those of a capacity to hold 50 c. cm. are more generally in use. In order to test the accuracy of the graduations the burette is calibrated. This is done by filling the tube with distilled water at a given temperature, then weighing the water delivered by successively measuring out according to the graduation the same volume of liquid. Any difference in the weights obtained will show at once what corrections are necessary for any variation in the bore of the tube. In reading the level of the liquid standing in the burette, the bottom of the meniscus should be taken for colourless solutions as the point to read from; to facilitate that, a piece of white paper is held at the back of the burette. If the liquid is coloured, the edges where the meniscus touches the tube is the point taken. When in use the burette is clamped vertically in a stand, and the convenience of the instrument is the ease with which it allows the operator to read off at once the quantity of liquid delivered. There should be no air bubbles in the tube. For a description of the different kinds of burettes the reader must consult a textbook on practical chemistry. [R. A. B.]

Burmah Pony.—This name is given to a small hardy pony which is bred chiefly in the hills of the Shan States. His most striking feature is the great depth of his body in comparison with its length. He stands about 13 hands, and is an exceptionally good weight-carrier, but rather slow in action. His legs are short and badly formed, being deficient in the forearm and thigh, and 'sickled' in the hock. They thus contrast oddly with his deep and well-developed body. The Burmah makes a fairly good saddle pony, and is used as a polo mount to some extent.

Burnet.—This is a perennial herbaceous plant belonging to the nat. ord. Rosaceæ, and to that part of the order whose flowers are destitute of petals. Its technical name is *Poterium Sanguisorba*, L. The stem grows to a height of about 2 ft., and bears leaves of the compound pinnate sort, like those of the rose. At the end of the shoot there forms in June or July a dense reddish-green spherical head of small flowers. The plant is a native of the chalk

hills of the south of England. Burnet has been recommended for growth on dry, calcareous soils either alone or in mixture with grasses and clovers. Time after time it has been tried and found wanting, for stock refuse to eat it unless



Burnet (*Poterium Sanguisorba*)

1, Calyx. 2, Male flower. 3, Female flower. 4, Hermaphrodite flower.

when pressed by hunger. Certainly on dry, chalky ground, where nothing better can be got to grow, Burnet is worth a trial. [A. N. M'A.]

Burns and Scalds.—These wounds of domestic animals are of rare occurrence fortunately; however, when they do occur, if at all extensive, they prove quite troublesome, and in many cases are fatal. According to the severity of the burn we distinguish three degrees: First degree, where there is a simple reddening of the skin; second degree, where there is a formation of vesicles or blisters; third degree, where there is a complete destruction of vitality of the tissues, such as would occur in charring from direct contact with flames or from escaping steam.

When a large surface of the skin is burned or scalded the animal will show signs of fever, shivering, coldness of the extremities, weakness, restlessness, quick and feeble pulse, and laboured breathing. No matter which agent is the factor in the production of burns, the lesions are practically of the same nature. The site and extent of the burn should lead one in the determination and course of treatment. Burns of the shoulder, and those about the region of the elbow or other parts where there is much movement of the tissues, are grave, and if at all extensive, treatment will be very tedious, and it is often questionable if any treatment will be compensated for, even though recovery does take place.

Treatment should be prompt and effective. If the burns are extensive, the constitutional symptoms should be combated with whisky and milk and eggs, or ammonia carbonate, strychnine, and other stimulants, to prevent shock, and a hypodermic injection of morphia is recommended to alleviate pain.

In the local treatment of burns with mineral acids (sulphuric, nitric, or hydrochloric), avoid water, as that will develop heat, but cover the surface with dry whiting or chalk, and only when effervescence has ceased, wash off with water. When the caustic has been a salt (copperas, chloride of zinc, &c.), apply lime water or white of egg. If the irritant has been a caustic potash, soda, or ammonia, vinegar should be the first application. Burns from flame or steam are well treated by liniment made of equal parts of lime water and linseed oil (known as carron oil to all druggists), and afterwards with boric-acid lotion. Blisters should be pricked with a needle and emptied, to prevent their rupture and the exposure of the raw surface. For all burns a very good dressing is composed of linseed oil and lime water, each 200 parts, bicarbonate of soda 100 parts, thymol 1 part. This is to be freely applied to the scorched surface, and covered over with a layer of boric gauze to protect it from the air. [H. L.]

Burnt Earth. See CLAY BURNING.

Burrow.—The typical rabbit burrow consists of a central chamber from 2 to 5 ft. below the surface of the ground, from which access is had to the exterior by means of several tunnels in different directions. The chamber is large enough to contain comfortably the whole family. The tunnel which constitutes the main exit starts downwards, but quickly turns up and reaches the surface at a steep incline. It is as a rule considerably larger than the other tunnels, which serve merely as bolt-holes in case of emergency. A different type of burrow from this is the nesting-hole of the female. This is dug out at the commencement of the breeding season, and consists of an apartment, lined by the female with a few leaves, and fur from her own body, access to the surface being had through one tunnel, of which the opening is often carefully concealed. It is as a rule at some distance from the main burrow.

Although the kind of land most suitable for burrowing is a sandy heath or peat, rabbits will, in order to be near good pastures, burrow in the hardest soil, and have even been known to take up their habitation in a surface seam of coal. Where the ground is flat, the burrows are extremely liable to be flooded in heavy rains, and every year quantities of young rabbits meet their death in the early summer from drowning in this way. Foxes occasionally inhabit rabbit burrows, and the domestic cat not infrequently takes to a wild life, feeding

largely on rabbits, and dwelling permanently in their burrows.

Artificial burrows are easily made, when it is desired to rear rabbits either for sport or the market. A dry bank, where plenty of sun penetrates, should be selected, and holes of about an arm's length should be made with a long planter's spade at the spots chosen for the burrows. The rabbits will take advantage of these holes, and soon excavate them into burrows to suit their own taste. Where there are no natural banks, mounds must be thrown up. Mr. J. Simpson, who has had great experience of rabbit-farming on a large scale at Wortley Hall, has given careful directions as to the manner of making these mounds, which he has found most successful. They should be circular, about 4 yd. in diameter at the base, and 3 ft. high. The earth of which they are made should be dug from immediately around them, so as to leave a trench surrounding each mound. The sods first cut should be thrown very loosely into the middle to form the bottom of the mound, and in such a way as to leave crevices large enough for the rabbits to shelter in before they have excavated their burrows. When once they are introduced to the mounds thus made, the burrows will be rapidly tunnelled out by the rabbits themselves. If the soil is such as to allow water to stand in the trenches, drains should be made to carry it off. It is important that the mounds should be evenly distributed over the pastures; shelter may be provided by throwing branches of trees on the mounds or in the trenches. [H. S. R. E.]

Bur Tree, Bor Tree, a popular name for the Elder. See ELDER.

Bush Draining, a kind of draining in which the drains are filled with bushes. See DRAINAGE.

Bushel.—This is the measure by which grain is generally computed all over the English-speaking parts of the world. It contains 1·28 c. ft., or 8 gal., and is usually referred to as the imperial bushel, to distinguish it from local measures formerly in use in various districts all over Britain, but which now are not only obsolete, but very seldom referred to even in conversation by the very oldest people. The tendency at the present time is not only to sell, but to compute all grain on a weight basis, and instead of selling wheat or other grain at so much per bushel or per quarter, to sell it at so much per 60 lb., or per 240 lb., or per ton, or other weight. Taken into consideration along with its appearance, weight per bushel of any grain is a very safe guide regarding its quality, but in other respects selling grain by weight in preference to measure is much the more satisfactory of the two methods. Seed grain is still mostly sold by the bushel or quarter. The following is the weight per bushel of average samples of the principal grains, feeding-stuffs, &c.:—

	lb. per bushel.
GRAINS.	
Barley	48 to 50
Oats	35 to 46
Wheat	60 to 63
PULSE, ETC.	
Beans	62 to 66
Dari	60
Lentils	62 to 63
Maize	60
Peas	62 to 64
CAKES.	
Decorticated cotton-seed cake	50
Linseed cake	43
Undecorticated cotton cake	38
MEALS.	
Barley meal	42
Bean meal	50
Cotton-seed meal	51
Maize meal	47
Oats (ground)	30
Paisley meal	48
Rye meal	32
ROOTS.	
Carrots	40
Marigolds	45
Swedes	45
Turnips	45
FODDERS.	
Hay (cut)	8
Oat straw (cut)	5
BY-PRODUCTS, ETC.	
Bran (wheat)	17
Brewers' grains (wet)	40
Brewers' grains (dry)	20
Malt coombs	14½
Salt	65

See also art. WEIGHTS AND MEASURES. [J. S.]

Butcher's Broom (*Ruscus aculeatus*).—This is an evergreen shrub, indeed the only monocotyledonous shrub that is a native of Britain. It belongs to the order Liliaceæ. Botanically the plant is very singular, for its branch stems look like spiny leaves, and indeed have to play the part of leaves, as the true leaves are reduced to mere scales. It is on these leaf-like branches that the flower and fruit are borne. The fruit is a bright-red berry about ⅓ in. in diameter. In the south and west of England the plant grows wild on dry sandy land, and to adapt it for growth in such habitats the leaves are reduced to scales, and the branch stems flattened out to play the part of leaves. Butcher's broom is frequently planted in shrubberies. [A. N. M'A.]

Butter.—Butter consists of the fatty matter of milk with a proportion of the other component parts of the milk, and is produced by a process of churning milk or cream till the fat globules coalesce to form granules; these are collected and the non-fatty constituents worked out as far as possible. A small percentage of salt is admissible in pure butter, but if this greatly exceeds 1 per cent the butter is called salt butter. Colouring matter and preservatives are also added to some butters, but their use is not generally admitted. The average composition of 340 samples of British butter dealt with in the Board of Agriculture inquiry (1901–2) came out at—water 13·05 per cent, curd 1·02 per cent, salt 1·02 per cent, and fat 84·91 per cent.

WATER.—The standard of 16 per cent is now fixed as the limit above which a sample of

butter 'shall be regarded as not genuine until the contrary is proved'. The water in butter may vary from some 20 per cent as it leaves the churn down to about 9 per cent in very well worked butter. The butter from different countries varies considerably as to the percentage of water which it contains, but where modern methods are used there is little difficulty in reducing it below the required standard of 16 per cent. Butters containing about 13 per cent water have the best flavour as a general rule.

The percentage of water is most easily determined by weighing about 10 gm. of the well-sampled butter (cut from different parts of the lump) into a flat-bottomed dish provided with a small glass stirrer. The dish is then placed on a sandbath over a small flame, and stirred till all signs of frothing cease. The curd must not become very brown, and spirting must be avoided by turning down the flame. After cooling and weighing, the loss in weight will give the water in the portion taken. More accurate results may be obtained by drying till constant at 100° C., having first weighed 2 gm. of the butter in a dish containing ignited pumice.

When the estimation of the curd and salt are also required, 4 or 5 gm. of the butter should be weighed into a wide-mouthed flat-bottomed flask; this should then be put in the drying oven and shaken every few minutes till the bulk of the water is expelled; drying is then continued till a constant weight is obtained. The fat is separated from the curd and salt by adding a solvent (ether) to the melted dry butter from the last experiment; the solids not fat quickly settle; the clear solution of fat should then be decanted through a tared filter paper, and the process repeated till no more fat is left in the flask. With practice, all the solids not fat remain in the flask, and may then be dried till constant. If any curd is on the filter paper, it should also be dried. The difference between the dry butter and dry solids not fat, gives the fat in the sample. The salt should be extracted from the curd with hot water filtered, and the filtrate titrated with a standard silver nitrate solution, using potassium chromate as an indicator. The weight of salt subtracted from the solids not fat gives the curd together with a small amount of milk sugar which is not often determined. A determination of the total ash may be made in the solids not fat. This will give a result slightly above the percentage of salt as found by titration, and will be swelled by preservatives such as borax, if such happen to be present.

Preservatives should be tested for in the aqueous portion which sinks to the bottom on melting the butter at a low temperature. Borax and boric acid are the most common preservatives, and can be tested for with turmeric paper; they may also be detected in the ash by the addition of a drop of sulphuric acid and a little alcohol, which should then be lighted in a dark room; a green tinge in the flame indicates borates. Nitrates, sulphites, and formalin may be tested for in the aqueous portion which separates from the butter on melting.

The above-mentioned 'proximate analysis of butter' is most valuable as an indication as to the way in which the butter has been made; it will afford evidence of over or under working, and will also indicate milk-blended butters and pickled butters.

In order to find out if the butter has been adulterated it is necessary to make a study of the physical and chemical properties of the fat.

Butter fat is of very complex composition; it consists of a mixture of glycerides, *i.e.* ethereal salts of the trihydric alcohol glycerol. The fatty acids with which this substance is combined are oleic, palmitic, myristic, lauric, butyric, caproic, capric, stearic, and caprylic; these are stated in the order of the proportion in which they are found in butter fat. It is highly probable that the glycerol base is united with three of these different acids at one time; for instance, we may have glyceryl butryo-oleo-stearate, which would have the formula:

$$\begin{array}{l} CH_2{\cdot}O{\cdot}CO{\cdot}C_3H_7 \\ \vert \\ CH{\cdot}O{\cdot}CO{\cdot}C_{17}H_{33} \\ \vert \\ CH_2{\cdot}O{\cdot}CO{\cdot}C_{17}H_{35}. \end{array}$$

One of these fatty acids may be replaced by phosphoric acid united to choline, in which case we have lecithin, a substance also found in butter fat. Traces of cholesterol may also replace a little of the glycerol. A natural colouring matter is also present.

Saponification of butter fat occurs on boiling with caustic alkali. Glycerol is set free, and if sodium hydrate is used as alkali the sodium salts of the fatty acids which were combined with it are formed. If an alcoholic solution of potash or soda is used, the saponification takes place more easily, due probably to a different stage in the hydrolysis. Alkali ethoxide, produced by the action of the alcohol on the potash or soda, first forms glyceroxide and esters, which are afterwards hydrolised into the soaps, the final products being the same as when an aqueous solution of the alkali is used. In view of analytical processes mentioned below it must be remembered that ethyl butyrate is volatile; it has a characteristic pineapple odour. The fatty acids are set free from the soaps formed by hydrolysis, by treatment with mineral acids. These fatty acids differ from those set free from the saponification and acidification of fats of vegetable and animal origin in the following particulars:—

Butter fat yields a larger proportion of volatile, soluble, fatty acids than other fats with which it may be adulterated, due chiefly to the presence of butyric and caproic acids. For the same reason, together with the presence of caprylic and lauric acids, the proportion of insoluble non-volatile fatty acids is lower in the acids obtained from butter fat than in fats of animal origin. The mean molecular weight is also lower and the density higher, also due to the presence of the above-mentioned acids in butter fat. The butter fat is also less crystalline in nature than animal fats. The refractive index and iodine absorption are lower in butter

than in margarine, due chiefly to the lower proportion of unsaturated fatty acids in the glycerides.

To prepare butter fat for analysis, about 50 gm. of the butter should be taken in a small beaker and placed in a water oven till melted. The fatty layer should be clear. Turbidity may be due to overworking, which may in turn be caused by mixing with margarine or other fats.

In few analytical processes is a standard more necessary than in the determination of the volatile fatty acids in butter; for the errors, as shown by Wollny, may be very considerable if the experiment is carried out in different ways. The method adopted by analysts in this country is the Reichert-Wollny process, which is as follows. 5 gm. of the liquid, filtered, clear fat are weighed into a 300 c.c. flask (length of neck 7 to 8 cm., width of neck 2 cm.); 2 c.c. of a solution of caustic soda (98 per cent) in an equal weight of water — preserved from the action of atmospheric carbonic acid—and 10 c.c. of alcohol (about 92 per cent) are added; and the mixture is heated under a reflux condenser, connected with the flask by a T-piece, for fifteen minutes in a boiling water bath. During this operation the side tube of the T-piece is pointed in an upright direction and closed with a rubber tube and clip. After fifteen to thirty minutes, when the saponification is complete, the side tube is turned down, opened, and connected with the condenser, the top end being closed with the clip; the alcohol is distilled off and the soap is left dry. 100 c.c. of hot distilled water, which has been kept boiling for fifteen minutes, is added through the top end of the T-piece, and the flask heated until the soap is dissolved. 40 c.c. of normal sulphuric acid and three or four fragments of pumice or broken pipe-stems are added, and the flask at once connected with a condenser by means of a glass tube 7 mm. wide and 15 cm. from the top of the cork to the bend. At a distance of 5 cm. above the cork is a bulb 5 cm. in diameter. The flask is supported on a circular piece of asbestos 12 cm. in diameter, and having a hole in the centre 5 cm. in diameter, and is first heated by a very small flame, to fuse the insoluble fatty acids, but the heat must not be sufficient to cause the liquid to boil. The heat is increased, and when fusion is complete, 110 c.c. are distilled off, being condensed in a Liebig condenser containing a column of water 30 to 35 cm. in length, the condensing tube of which is 8 mm. in diameter. The distillation should take thirty minutes. The distillate is shaken, 100 c.c. filtered off and titrated with deci-normal soda or baryta solution, using phenolphthalein as an indicator. Precisely the same procedure (with the same reagents), omitting the fat, should be followed, and the amount of deci-normal alkali required to neutralize the distillate ascertained. This should not exceed 0·3 c.c. The volume of deci-normal solution of alkali used, less the figure obtained by blank experiment, is multiplied by 1·1. The number so obtained is the 'Reichert-Wollny Number'.

A Reichert-Wollny number of 24 has been suggested as the limit below which the presumption of adulteration should be raised. This, however, has not been agreed on, and the fact that over 40 per cent of butters made from the milk of six cows at the Midland Agricultural and Dairy College during one year were below this figure shows that such a standard would not be just. It is, however, a very rare thing to get a genuine butter with a lower Reichert-Wollny number than 20, and this could only be where the milk of very few cows was taken to make the butter. For commercial butters, 24 may be taken as the limit, and it will be found that over 80 per cent will fall between 30 and 26. With margarine there is practically no volatile fatty acid. With cocoanut oil, the Reichert-Wollny figure is about 7.

With cocoanut oil, although the soluble, volatile, fatty acids are reduced, the insoluble, volatile, fatty acids are increased. On this fact is based the Polenske method for the detection of cocoanut oil in butter. In this method 20 gm. of glycerol replaces the 10 c.c. of alcohol used in the Reichert-Wollny method. A perpendicular condenser is also used. After filtration of the distillate, and washing with a further 25 c.c. of distillate and 18 c.c. of water, the insoluble fatty acids are dissolved in alcohol and titrated. This 'new butter value' varies from 1·5 to 3 in butter, and from 16·8 to 17·8 in cocoanut oil.

The estimation of the mean molecular weight, insoluble and soluble fatty acids in butter may be conducted in one portion of butter fat. The estimation is conducted as follows:—

About 4 gm. of butter fat are weighed into a flask which has been boiled with caustic alkali solution and washed with boiling distilled water. 50 c.c. of $\frac{N}{2}$ alcoholic soda solution are added, and the flask is fixed to an inverted condenser and boiled for a quarter of an hour. Phenolphthalein solution is then added, and the liquid titrated in the flask with $\frac{N}{2}$ hydrochloric acid till the pink colour is discharged.

The $\frac{N}{2}$ alcoholic soda solution is made by dissolving 25 c.c. of a 50-per-cent caustic soda solution in alcohol, and making up to 1 litre. The cleared solution should be titrated against $\frac{N}{2}$ hydrochloric acid every time it is used. The number of c.c. of hydrochloric acid used in the titration of the free alkali in the flask is subtracted from the c.c. of acid which have been found equal to the 50 c.c. of alcoholic soda taken. This figure multiplied by 2·805, and divided by the weight of butter taken, will give the percentage of potash required for the saponification. This figure for butter is about 22·7 per cent, for margarine 19·5 per cent, and for cocoanut oil 26 per cent.

The contents of the flask in which the titration was performed are now washed into a large porcelain basin, and the alcohol driven off on a water bath. About 200 c.c. of boiling distilled water are now added, and enough of the hydrochloric acid solution to make with the volume already used in the titration 1 c.c. more

than the equivalent of 50 c.c. of the alcoholic potash in terms of $\frac{N}{2}$ hydrochloric acid. The dish is now heated on the water bath till the insoluble fatty acids float on the surface in a clear layer. A good filter paper is next well wetted with water, and the liquid from the dish poured on, the dish and the fatty acids on the paper being well washed with hot water. As an alternative, the contents of the dish may be transferred to a separating funnel and there well washed with hot water; the liquid and afterwards the washings are run off into a litre flask. The filtrate (which should be about a litre in volume), or an aliquot portion of it, is now titrated with the alcoholic potash, using phenolphthalein as an indicator. The total equivalent in terms of hydrochloric acid of potash taken to neutralize the filtrate, minus the 1 c.c. previously added in excess, are multiplied by 4·4, and divided by the weight of butter taken, which gives the soluble fatty acids in terms of butyric acid. This for butter is about 6 per cent, for margarine none.

The well-washed insoluble fatty acids are run from the filter paper or separating funnel into a weighed flask, traces which adhere being washed into the same flask with hot alcohol. After evaporation of the alcohol, the flask is dried in the water oven till constant. The percentage of insoluble fatty acids found in butter is about 87·5, and in margarine 95·5; in cocoanut oil 85 per cent is found.

For the estimation of the iodine absorption, the iodine solution must be mixed the day before. This consists of two parts, of which equal volumes are taken. Part 1 is made by dissolving 25 gm. of iodine in 500 c.c. of 95-per-cent pure alcohol. Part 2 consists of 30 gm. of mercuric chloride, dissolved in 500 c.c. of the same solvent.

0·4 to 0·5 gm. of fat is weighed into a stoppered bottle, 10 c.c. of chloroform is used to dissolve the fat, and 20 c.c. of Hubl's iodine solution mixed as above. A blank is started at the same time with 10 c.c. chloroform and 10 c.c. iodine solution. Both bottles are placed in the dark for four hours, after which 15 c.c. of a 10-per-cent solution of potassium iodide is added to each bottle, and about 200 c.c. of water. The contents of the bottles are now in turn titrated with $\frac{N}{2}$ sodium thiosulphate solution till on shaking only a very pale colour is left in the water or the chloroform; a drop of starch solution is then added, and the titration with thiosulphate continued till the blue colour is discharged.

The number of c.c. of thiosulphate, multiplied by the value of 1 c.c. in terms of iodine used in the blank experiment, gives the total amount of iodine added to the fat; the number of c.c. of thiosulphate similarly multiplied, used in the actual experiment, gives the weight of iodine not absorbed by the fat, and the difference between these two gives the quantity absorbed. This multiplied by 100, and divided by the weight of fat taken, is the iodine absorption. The sodium thiosulphate solution does not keep well, and should be standardized with a known weight of pure iodine, or with that set free from a known weight of potassium iodide before use. The iodine absorption for butter is about 37, for margarine about 55, and for cocoanut oil about 9.

The most rapid method for distinguishing between pure and adulterated butter fat, and one which is very suitable for sorting a large number of samples, depends on the determination of the refractive index of the sample. The best instrument for this determination is the butyro-refractometer made by Zeiss, which consists of two water-jacketed prisms, between which the clear butter fat is placed; a mirror reflects the light through these, and the temperature, which is checked with a thermometer fixed in the instrument, is kept constant with a stream of water which flows round the prisms.

The milled head on the side of the instrument is opened, letting down the bottom prism; the instrument is slightly tilted forward, and the clear fat spread evenly over the surface of the prism; it is then closed again, the temperature being adjusted by increasing or diminishing the stream of water. On looking through the eye-piece a dark shadow is seen across the scale. The position of the edge of this shadow gives the scale divisions. At a temperature of 35° C., genuine butter gives a reading between 43·5 and 49 degrees, while margarine will give a reading of about 54 degrees. The reading for cocoanut oil will be low, about 43 degrees.

The density of butter fat may be taken at 37·8° C. in a Sprengel tube, and compared with water at the same temperature. The density of butter fat is about 0·913, and of margarine about 0·902. [J. Go.]

Butter, Marketing of.—Until recent times, marketing of butter has been for the most part primitive and unmethodical. This is practically unavoidable when butter is made in a hundred different dairies, and taken to a provincial market in a hundred different baskets, in half-pound lumps done up in a hundred different ways and patterns. The best way has been indicated for years at the London Dairy Shows, in brick-like forms simply but effectively adorned by indented cross lines quickly made by the edge of a 'Scotch hand'. Our aim should be to offer good butter in forms attractive to the public. See next art. [J. P. S.]

Butter, Ornamental.—The best ornament butter can have is first-rate quality, that will tickle the palates of customers and make them 'cut and come again'. Yet, for all that, there are certain adventitious adornments that please the eye, and enhance the pleasure that fine quality affords; but it must be remembered that no amount of ornament will make butter go down pleasantly if quality is absent. There is money, however, in the make-up of butter, and of that not a little. All customers of taste like their butter tastefully made up for the table, but all the same they like quality still more. For practical purposes, apart from mere display, the way they make up 'bricks' of butter at the dairy schools cannot be beaten.

And this brick style, simply 'herring-boned' on the upper side, with the front edge of a 'Scotch hand', has the triple merits of handiness, effectiveness, and packing with a minimum loss of space in a basket.

A feature very attractive in the London Dairy Shows for many years past has been the class for ornamental displays of butter made up into splendid nosegays, shields, &c. Some of these have been triumphs of art, design, and deft modelling. A few have been indescribably chaste in conception and exquisite in manipulation. In so evanescent a substance as butter, the effect is only for very few days. But as thousands of people have seen and enjoyed these floral displays, and as the whole thing has strongly tended to popularize the gentle art of buttermaking, the trouble bestowed, great though it was, cannot be said to have been thrown away. [J. P. S.]

Butter, Statistics of.—The production and consumption of butter in the United Kingdom has been the subject of repeated enquiries and of somewhat varying conclusions. The quantity produced at one time or another is of course greatly affected by the current values of dairy produce and the demand for milk for direct consumption. The estimates which have been hazarded from time to time as to the consumption of butter per head of the population largely depend also on the weight given in the calculation to the consuming power of the different classes of the community whose use of butter varies widely. The absolute dimensions of the national consumption are not easy to construct from the mean of observations differing so widely, as from the 5 lb. per head suggested by one authority as the probable quota of an agricultural labourer's yearly butter ration, and the 32 lb. per head attributed in another scale as prevailing in well-to-do families in towns. The most recent and authoritative enquiry was that of a Committee of the Royal Statistical Society in 1903–4. In their reports, and in the observations submitted by Mr. R. H. Rew on that occasion, reference is naturally made to some of these older and looser estimates, but for practical purposes it may be more useful to reproduce the findings of this Committee than to seek to reconcile and explain the differing results of earlier investigations. The Committee concluded that an available average annual total of 1,723,000,000 gal. of milk was produced by the cows of the United Kingdom, and more than half of this, it was suggested, was turned into butter — the 944,000,000 gal. so employed yielding 3,211,000 cwt., or 160,000 tons of butter. Divided among the mean population of the period on which their estimates were rested, 1899–1903, this gave a home supply of 8·7 lb. per head. The ascertained figures of the net imports of butter from abroad, 3,638,000 cwt., reach a further quota of 9·8 lb. per person, so that the probable aggregate of butter consumption in the United Kingdom is equal to 18·5 lb. per unit of the population. If the home supply has been maintained, which is doubtful in the face of the growing direct demand for milk, the head rate now available would be nearly a pound greater per person owing to the increased volume of imported butter in the years following 1903.

It is not, however, desirable to forget that there is an element of doubt in all these calculations, so far as the share taken by our native stock in the production of butter is concerned, while definite statistics are lacking of the proportion of the butter supply which Ireland furnishes to the British consumer. The last published figures of the Irish Department, admittedly imperfect as regards the trade by parcel post, and the sale of small consignments under 28 lb., which is presumably large, only gave a net Irish export of some 32,000 tons, which would seem too small a proportion of the 160,000 tons of British and Irish produce suggested by the Statistical Society's Committee, and it may be necessary on this point to await fuller information. Certainly Ireland has from an early period formed a very important source of the British consumers' butter supply, and one would have expected that the development of her trade under the influence of better instruction and co-operative methods must have told on the output.

Much safer ground is reached in examining the volume and the sources of butter imported from abroad. There was some importation of the kind even early in the 19th century, coming chiefly from the Continent, and in particular from Holland. A total, it would seem, of 211,000 cwt. was imported in 1827, and as much as 331,000 cwt. in 1850 — two-thirds of this being Dutch — while Germany furnished the next largest quota. Between 1857 and 1860 the receipts of foreign butter nearly doubled, arrivals reaching 840,000 cwt. being recorded in the latter year, and over a million cwt. was received by 1862. This average was maintained over the succeeding years, and when the receipts of margarine, which had been included in the total up to 1886, were deducted in that year, it was found we were receiving 1,543,000 cwt. annually of butter properly so called, besides 888,000 cwt. of the commodity known under the other designation. Since that date the development of the import trade is clearly recorded in the returns, and the imports of butter and of margarine have been respectively in round numbers as under:—

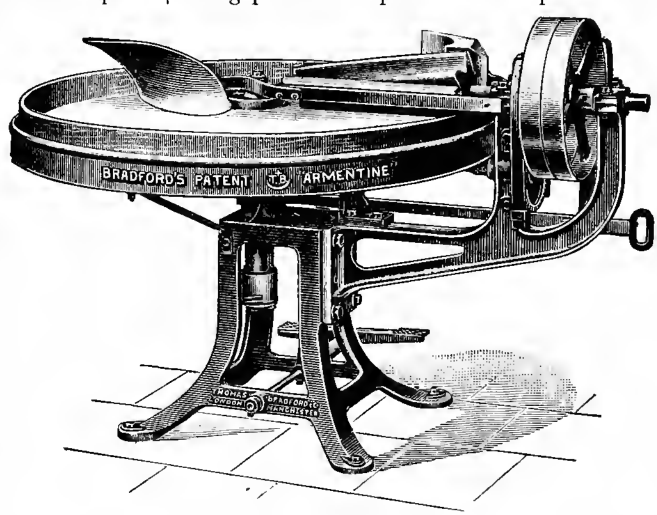
	Butter.	Margarine.
Period 1886–90	1,740,000 cwt.	1,125,000 cwt.
„ 1891–5	2,410,000 „	1,178,000 „
„ 1896–1900	3,250,000 „	927,000 „
„ 1901–5	4,020,000 „	972,000 „
Single year 1906	4,340,000 „	1,102,000 „
„ „ 1907	4,210,000 „	885,000 „

The margarine imports have thus apparently fallen back to their original dimensions as first separately recorded, while the butter has multiplied in volume. In 1886 more than one-fourth of our imports came from Scandinavia—Denmark sending 26 per cent from her own ports. France was second with just the same proportion, and Holland not far behind with 23 per cent. By 1895 Scandinavia supplied more than half of the total (52·6 per cent), and the Danish share alone was 41 per cent, the French

dropping to 16 per cent, and the Dutch to under 7 per cent. Our Australian colonies supplied in that year 11 per cent. The growth of the supply has not been perhaps quite so marked in recent years, and rather less has come in 1907 than in 1906. It is apparent, however, that Denmark, after a pause in its exports of butter, has again increased its supplies—sending more than two-fifths of the whole. The Russian supply is also again increasing, and the production of Siberian butter for export seems a feature capable of further expansion; while the colonial exports, which were only 2 per cent of the whole twenty years ago, now usually exceed a fifth of our supplies, the falling off in the Canadian supply being met by large additions from Australasia.

The collection of prices of butter, so far as domestic produce is concerned, is not easy; and the difficulty is not even yet wholly surmounted in the more extended tables of the weekly and annual values of agricultural produce supplied by the Board of Agriculture. In a recent report from that office it is shown that the first quality of British butter was priced distinctly higher than Danish. The British quotations, however, relate to much smaller individual transactions, and represent sales by the pound or by the dozen pounds rather than by the cwt., in which both the Irish and the Foreign trade in imported butters is conducted. In 1906 the equivalent of the British price of 14*s.* 3*d.* per 12 lb. is 133*s.* per cwt., against 118*s.* 6*d.*, while Irish creamery butter was put at 111*s.* 6*d.* In 1907 lower average values are quoted both for British and Danish produce. If any consecutive series of butter values is desired, recourse must be had to the published prices, which are given in certain parliamentary returns, for the earlier portion of the 19th century. The first of these, resting on quotations of purchases at Greenwich Hospital, run back to 1820, and for the considerable period up to 1840 the price per cwt. fluctuated somewhat widely. A minimum of 67*s.* 8*d.* per cwt. was recorded in 1823, and although a quotation of 98*s.* per cwt. was reached on a few occasions, no price exceeding 100*s.* per cwt. is mentioned before 1841. Thereafter the values ascertained for imported butters are generally used, the Irish supplies varying between 56*s.* and 96*s.* per cwt. up to 1853. Quotations after this date are those of foreign butters, for some time the prices being given according to the country of origin, and varying from 68*s.* 4*d.* in the case of American arrivals in 1854 to a maximum of 129*s.* 6*d.* in some German butters received in 1868. For later dates the official quotations average all imported butters together, and so high a figure as that just mentioned is not again apparent, although prices remained above 100*s.* per cwt. up to 1885. Another set of calculations, made for quinquennial periods from 1861 to 1885, give average values ranging upwards from 100*s.* 6*d.* to 110*s.* 1*d.*, and dropping again to 101*s.* 10*d.* After 1886 it became possible to separate butter imports from those of margarine, previously included, and the prices for butter alone have not shown great annual variation, a value of 106*s.* 8*d.* per cwt. in 1891–5 being the highest, and 100*s.* 10*d.* in 1896–1900 the lowest. For 1906 the average price level rose to 108*s.* 2*d.* per cwt., and for 1907 it was 106*s.* 6*d.* But as in all other commodities where prices depend largely on quality there is necessarily a wide range, and for the last two seasons of twelve months ending 30th June, 1907, the price of best Danish butters was quoted 119*s.* 9*d.* and 118*s.* 3*d.* respectively. Much higher values were temporarily reached early in 1908, but the price by the summer of that year has receded to 113*s.* per cwt. [P. O. C.]

Butter-blenders.—For machines to manipulate butter in every stage between cow and market, the firm of T. Bradford & Son have for a long period been predominant experts as inventors and makers. An illustration of their 'Armentine' Butter-worker shows a machine, for power, which will serve either as a 'blender' of different butters in large export establishments, such as are to be found in France, or as a manipulator of butter fresh from the churn, in creameries which are not uncommon now in the British Islands, especially in Ireland, where indeed they are a *sine qua non.* There are various types and sizes of these instruments, from hand-power workers to the greater ones that require such power as steam or electricity supplies. It is sufficient to say that these butter-workers are more efficient in all respects, and more to be preferred from all points of view, than the bare and unaided hand of a dairymaid. Butter kneaded and formed into shape by human hands cannot possibly be equal to what the same butter would have been



Power Butterworker

if manipulated by butter-workers and 'Scotch hands'. [J. P. S.]

Butterbur (*Petasites vulgaris*), a plant with huge heart-shaped leaves like rhubarb, 2 or 3 ft. broad, densely coated with white down on the lower surface, often found growing on river banks and on moist sandy meadows. It is a perennial herb of the same family as Coltsfoot, namely Compositæ. Underground there is a stout stem, which shoots out freely. Early in the year, from this stem there grows up the flower-bearing shoot. Here, then, is a very unusual case—the flowers are produced before the leaves, and this peculiarity Butterbur shares with its ally Coltsfoot. This flower-making shoot bears only rudimentary leaves; at the top it branches out so as to bear many flower-heads of a pink or fleshy colour and about ½ in. in breadth. There is not, as in Coltsfoot, one flower-head per flowering shoot, but many flower-heads. On some plants the heads of flowers are arranged quite loosely, on others they are compacted together. The loose heads alone make seed; the compacted heads can make no seed, but produce pollen only. In Butterbur, then, we have distinct male and female plants, and to prevent spreading by seed we have merely to remove the tops of the female plants in the month of April. When flowering is over, the underground stems send up the foliage leaves for purposes of food manufacture. Although the plant is called Butterbur there are no burs about it; the name is said to refer to the fact that the large leaves were formerly used for wrapping up butter. [A. N. M'A.]

Buttercups.—These are weeds belonging to the genus Ranunculus and nat. ord. Ranunculaceæ. Being very common, they have received various names, such as Crowfoot, Crowtoes, &c. They abound in pastures, inextricably mingled with the herbage. All the species are acrid poisons, but their poisonous principle being volatile, they cease to be dangerous when dried and made into hay. Many of the common buttercups, if bruised and bound upon the skin, produce severe inflammation, which proves their irritating nature.

The commonest species are: (1) Corn Buttercup (*Ranunculus arvensis*, L.); (2) Upright Buttercup (*Ranunculus acris*, L.); (3) Creeping Buttercup (*Ranunculus repens*, L.); (4) Spearwort Buttercup (*Ranunculus Flammula*, L.).

1. Corn Buttercup.—This is an erect annual species frequent in cornfields, about a foot high, and bearing pale-yellow flowers. It is easily distinguished when in fruit by its *prickly* achenes. If allowed to mature and sow its seed containing achenes, the Corn Buttercup may become a very troublesome pest.

2. Upright Buttercup.—This perennial species is very common in meadows and pastures, and varies in height from 1 to 3 ft. It seeds freely, and should be kept down to prevent spreading by 'seed'. The flower-stalk has no ribs and furrows like the next species. Care should be taken that this Buttercup is not allowed to fruit near the hens, for poultry pick off the seeds and are sometimes poisoned thereby.

3. Creeping Buttercup.—This is another perennial Buttercup quite common in damp pasture and arable land, which spreads rapidly by means of its runners, in the same way as a strawberry. In this species the flower-stalk has ribs and furrows.

4. Spearwort Buttercup.—This is a poisonous plant common in marshes and ditches. The stock should not have access to this dangerous poison. The leaf is not compound as in an ordinary Crowfoot, but all in one piece, and has the shape of a lance. The flower also is much smaller than in the other species. The lanceolate leaf and the small yellow flower suffice to distinguish this poisonous marsh plant. [A. N. M'A.]

Butter-extractors.—Butter-extractors are a hypothetical combination of separator and churn. At present the possibility of producing butter purely by mechanism has not revealed itself, although who shall say that a machine will not yet be invented to milk cows, separate milk, and churn butter, all in one continuous process? It is difficult, however, to discern any advantage to accrue of importance sufficient to make it worth any mechanician's while to invent and construct a machine so costly and so complicated that its sale would probably be very limited indeed. The cream separator has done much to revolutionize buttermaking—so much, indeed, that there seems little or nothing for a butter extractor to do that is worth doing. The separation of cream from its milk, its matrix, is a process which, in the old way, was purely natural and automatic, and in the new way is performed mechanically in a way that leaves little or nothing to wish for more. It is a process, too, that lends itself well to mechanical precision, without any misgiving of harm as a sequel. But this is not the case in respect to the separation of butter from cream, a process which needs the dairymaid's eye, and careful modification from time to time, in one way or another, as expediency suggests. It seems somewhat futile, therefore, to expect a mechanism to perform work that requires careful manipulation and variation in different portions of the process. [J. P. S.]

Butterfly.—The butterflies belong to the order of insects Lepidoptera, the general characters of which are considered in the article on Entomology. Three species are of agricultural importance in Britain, the large and small white butterfly, and the green-veined white. These are treated in the art. Pieris.

Buttermaking.—Milk is one of the most complex and interesting fluids in nature—perhaps more complex than any other—and accordingly an art devoted to the manipulation of it into forms so dissimilar from it as cheese and butter must be greatly dependent upon the progress of science. Buttermaking is therefore to-day a more complex process than it was in the pre-scientific ages.

It will be seen by reference to the article on milk (see Milk) that among other constituents it contains on an average about 3·75 per cent of butter fat. The object of 'cream raising', so called, has always been to separate the butter

fat from the milk as completely as may be possible under the circumstances, in order to facilitate its manufacture into butter. This butter fat cannot, however, be entirely separated from the milk, even by mechanical means, the movements of some of the globules being more or less erratic. Some of them neither ascend nor descend, whilst the great majority rise toward the surface when milk is at rest in a pan. It has been observed, too, that a few globules actually gravitate slowly downwards, and this is very remarkable.

Until less than a generation ago cream raising was effected only by means of gravity; the cream, being the lighter, rose to the surface, and the skim milk, being the heavier portion, settled under the cream. The difference of 4 per cent in weight between milkless cream and creamless milk serves to separate the one from the other, when both are undisturbed for a day. When the separation is sufficiently advanced, the cream is removed by a skimming-dish and put into a crock or other vessel for a few days to ripen. All this is as old as civilization, but it still remains in force in many home dairies. During the last generation or so much more progress in buttermaking has been made than in all previous time. This is largely due to Laval's invention of the cream separator in 1877. Since that time the cream separator has undergone very great transformations and improvements, and in consequence the art of buttermaking has been revolutionized. See arts. CREAM RAISING and CREAM SEPARATING.

The progress of scientific buttermaking has been expedited by another discovery of the greatest importance in butter dairying, wholly different alike in character and influence. This discovery relates to the ferment-producing bacterium which is known to science as the *Bacillus lacticus* or milk bacillus. This bacterium finds in milk the most suitable field for its activity and its depredations, which, until recently, well within our own day, were not controllable by the dairymaid. For, it must be borne in mind, the presence of the ferment in the dairy — in the milk, indeed, before it comes inside the dairy—is unavoidable: but at the same time the ferment is a necessity, alike in cheesemaking as in buttermaking, and the best products of the dairymaid's art depend to a much greater degree than is commonly understood on the co-operation of the *Bacillus lacticus* in the work of the dairy. Ripening by means of 'pure cultures' of the lactic-acid bacillus, technically called 'starter', is the scientific form of ripening, and natural ripening the unscientific. That is to say: the former is precise and unvarying in action, provided the starter has been carefully prepared. The 'pure-culture starter' is obtainable from some of the dairy schools, in a condition to be relied on for work in a private dairy. It is prepared for use by being well stirred into pasteurized milk, and kept at 80° F. until the milk has become sour. A portion is then used to ripen cream that awaits churning, and the rest is put into other pasteurized milk for subsequent use. In this way a starter is held ready for use any day; but as by repeatedly inoculating fresh lots of pasteurized milk the starter seems to weaken somewhat, it is considered good practice to obtain a fresh supply of pure culture from the dairy school whenever the starter shows obvious signs of weakening. Whenever a starter is found to be too feeble to do its work effectively, the next lot should be made somewhat stronger by the infusion of a larger quantity of pure culture into a given quantity of pasteurized milk.

It is essential that dairies should be kept as clean as possible and well ventilated, in order to prevent the intrusion of rival bacteria which can do no good and may do much harm. The lactic-acid bacterium is the only one that can be safely admitted inside a dairy. Should any other obtain an entrance, surreptitiously or otherwise, it must be expelled; and only cleanliness, limewashing, ventilation, or disinfection can expel it. As a general rule, cleanliness, systematically employed, will be found sufficient if the dairy is situated where it can be often ventilated with good air.

Cream emerging from a separator at a temperature of about 100° F. more or less, may be cooled down to about 65° or 68° F., and the starter added to it for ripening. Should the cream have been reduced—as in the deep-setting system — to freezing-point, it would require warming up to 68° or 70°; but its ripening would be slower than that of cream which had not been brought below 65° F., and its buttery flavour would not be so well developed. Whereas a low temperature for cream-raising was considered less than thirty years ago to be a good thing for the cream, inasmuch as it checked the development of acidity — lactic, butyric, or any other—it is now properly considered a disadvantage. There is no need now to check the development of acidity in cream, because the introduction of a starter gives precedence to the one form of acid—lactic acid—which is indispensable, and it quickly becomes predominant, properly ripening the cream for the churn.

It must be borne in mind that unripened cream yields butter that is more or less insipid, and is often difficult to churn. The ripening of cream makes churning a shorter and pleasanter task, which is a manifest advantage. And as the full, rich, mellow flavour of butter is now understood to be in part owing to the development of lactic acid in cream, this particular bacterium performs double duty. The period during which ripening must be at work will vary according to circumstances, relating chiefly to temperature and to the quantity of starter employed. The degree of ripeness may be decided by taste and smell of the cream. An expert buttermaker is seldom at a loss to form an opinion on this important point. In order that all the cream to be churned at any given time may be equally ripe throughout, it is expedient to stir the cream now and again with a wooden rod. Cream so treated will be ripe for the churn in twelve or fourteen hours, and will require from ten to thirty minutes' churning, for cream does not

always ripen uniformly throughout unless due care is taken. [J. P. S.]

Although it is generally conceded that the finest quality of butter is made from pasteurized separated cream ripened with a culture starter, the older methods of ripening and churning whole milk and hand-skimmed cream are both favoured in special circumstances. The churning of sweet cream is also practised to a limited extent.

Whether butter should be made from whole milk or cream depends on circumstances. Both systems have been extensively practised in the past, and though the churning of whole milk is still a common practice, the churning of cream may now be considered the principal method of buttermaking. Where large quantities of milk are being handled, labour is saved, and space in the dairy or factory conserved, by using the separator, which immediately reduces the material to be used to about one-fifth of its original bulk. The loss of fat is also reduced by its use. On the farm, however, especially where there is a demand for buttermilk, whole milk may be churned to advantage.

The following practical instructions should be thoroughly grasped by the student in the art of buttermaking. As has been pointed out above, the cream which comes from the separator at a temperature of not less than 90° F. is rapidly cooled down to about 65° when the necessary amount of starter is added to it. Ripening is best done in glazed earthenware crocks or in enamelled vessels. All vessels should be thoroughly scalded before being used. The ripening room should be well ventilated, and should not be directly exposed to sunlight, which has a bleaching effect on the cream. During very hot weather it may be kept cool by opening the windows and hanging a wet muslin cloth across the apertures. If the cloth is allowed to dip into a vessel of cold water it will prove equally effective in cooling the air and keeping out dust. The most favourable ripening temperature is from 60° to 74°.

The quantity of starter to be used varies within wide limits, depending on the quality or virulence of the starter itself, on the season of the year, and on the time to be allowed for ripening; less being required when the starter is good, when the weather is warm, and when the ripening period is long. A quantity equal to from 3 to 5 per cent of the cream to be ripened may be taken as a fair average, but enough must be added to have the cream properly ripened when it has to be churned. The richness of the cream has considerable effect on the ripening process. Only the serum, principally the milk sugar, undergoes alteration, and if the percentage of fat is too high an even ripening is never got. Cream containing about 20 per cent fat is perhaps the most suitable for buttermaking, though it will ripen nicely with anything up to 30 or 35 per cent fat. Properly ripened cream has a uniform consistency, is free from any appearance of bleaching or other discolorations, and has a pleasant acid taste. It shows acidity, when tested by the acidimeter, equal to about 0·5 per cent lactic acid. It is important to stop the ripening process at the proper time, and this can be done by lowering the temperature, but if possible cream should be churned immediately after it is properly ripened. Butter got from partially ripened cream has neither the full flavour of that got from well-ripened cream, nor the characteristic creamy flavour of that got from sweet cream. On the other hand, if the cream is overripe it gives butter that becomes rancid very quickly. Another great objection to overripening the cream is that the casein forms small white specks of curd that cannot be separated from the butter, and butter containing these will not keep longer than a few days.

Where a separator is used it is advisable to ripen the cream from each separation in a separate vessel, but it is impossible to do this with hand-skimmed or gravity cream, and consequently it is more difficult to secure an even ripening with gravity cream than with separator cream. An interval of at least thirty-six hours must elapse before the whole of the cream can be removed from the milk by hand-skimming, and in that interval many bad flavours may be developed. This is the chief cause of a lack of uniformity in the butter made from cream got in this way. As soon as the first cream is removed from the milk it should be put into the ripening vessel and the starter added. The remaining cream is added at intervals, and the whole well stirred for the reasons already explained. No new cream should be added later than twelve hours before churning, as a mixture of well-ripened and partially ripened cream can never give the best results.

In the ripening and churning of whole milk a few points call for special mention. Whole milk is usually set for ripening in large oak casks immediately it is drawn from the cows. It requires from forty to sixty hours to ripen, and enough starter, say 2 per cent, should be added to give a nice, though not too firm, coagulum in the desired time. The starter is well stirred into the milk, and a few hours later the cream which has risen should be stirred down, but after that the milk is left untouched until it is ready for churning. On no account must the partially ripened milk be stirred, or the casein will settle out in the form of curd, carrying much of the fat with it. Shortly before churning, the milk is brought as near to the churning temperature as possible. This is essential, as little or no water is added to milk in the churn. Milk is quite suitable for churning without the addition of water, and moreover much added water would spoil the quality of the buttermilk. A higher churning temperature is required for milk than for cream, varying from 58° to 65°. A longer time is also required for churning, two hours or more being necessary. Apart from these points mentioned, the remaining steps in the process of buttermaking are practically the same for separator cream, gravity cream, and whole milk.

The churn, of whatever type (see CHURNS AND CHURNING), is thoroughly scalded and then cooled to the churning temperature as a pre-

liminary operation. The cream, which is usually too thick for churning, is then diluted with water and brought to the proper temperature. The churning temperature varies with the season of the year, the consistency of the cream, the lactation period of the cows, the breed of cows from which the cream is got, and the feeding used. It may be put at from 48° to 62° according to circumstances. A lower churning temperature is required in summer than in winter, while the milk of Jersey and Guernsey cows can be churned at a lower temperature than that of Shorthorns or Ayrshires, because the fat exists in it in larger globules and these coalesce more readily. Cream from newly calved cows churns easily and at a low temperature, while such foods as cotton cake and linseed cake show the effect of feeding very well, the former giving hard butter requiring a high churning temperature, and the latter soft butter requiring a low churning temperature. After the cream has been prepared the butter colour is added and thoroughly incorporated. The quantity to use must be regulated by the natural colour of the fat and by the market demands, but one teaspoonful to 5 or 6 gal. of cream gives a good colour. The colour is added to cream before churning is begun, but whole milk must be churned some little time before it is added, to break up the coagulum and allow it to become incorporated.

The time required to churn cream may vary from twenty minutes to an hour, according to the temperature, quantity being churned, &c., but it should seldom exceed the latter time unless with very large quantities. If the cream is 'sleepy' or the butter is slow in coming, the temperature is raised slightly by adding a little warm water, which will usually cause the butter to appear in a short time, but water at a temperature of over 80° must never be added to the churn or the texture of the butter will be ruined. An expert churner can always tell by the sound when the butter is beginning to form, the splash of the cream sounding more sharp and watery. When the butter is beginning to show a decided grain a little water is added—the breaking water—at a temperature two or three degrees lower than the churning temperature. The churning is then continued until the butter is properly formed. It is often found advisable to add the breaking water at two or three times rather than all at once. Only end-over-end churns, or churns of a similar type, give granular butter, and if the butter has been properly managed the grains should be like rather large turnip seed in size. The chief advantage of having the butter granular is the ease with which it can be washed free from all traces of buttermilk, its keeping qualities being consequently improved.

As soon as the butter is properly formed, the buttermilk is run off and the butter washed once or twice with water a degree or two lower in temperature than the breaking water used. The process of washing is very simple, the water being put into the churn and the churn revolved a few times. The water is then run off and more added. A strong brine—about 1 lb. to a gallon—a few degrees colder than the washing water may be used for the last washing, the butter being left in it for ten or fifteen minutes. The butter is then removed to the butter-worker, which should have been previously scalded and cooled, and kept damp by filling it with water or brine and spreading a wet muslin over the roller. The butter should never be worked on a dry butter-worker. The deeply fluted roller of the worker is then passed over the butter a sufficient number of times to reduce the moisture content to about 12 per cent. To do this without turning the butter into a greasy mass requires considerable skill, and to facilitate the removal of the moisture the worker is wiped dry after each turn of the roller. As soon as the butter has been properly worked it is weighed, while still soft, usually into half-pounds, and is made up for the market into bricks, rolls, or prints.

If the butter has to be powdered or salted, the salt is added and thoroughly incorporated during the process of working. The salt is added gradually, and after the butter has been partially worked it is left for half an hour to allow it to become thoroughly melted. The working is then completed, and if properly managed the salt should be evenly distributed throughout the whole mass, and there should be no appearance of streakiness. Fine-grained salt is the most suitable. For powdering, $\frac{1}{8}$ oz. of salt to each pound of butter gives a nice flavour, while for salting, $\frac{1}{2}$ oz. to each pound of butter is enough; but the amount of salt to use must always be regulated by the market demands. Powdered butter is usually marketed in the same way as fresh butter, but salted butter is packed in bulk into crocks, kegs, or boxes. In packing salted butter it is essential to pack tightly, leaving no air spaces either round the edges or in the mass of the butter. It is round such air spaces that salted butter first becomes rancid. See also arts. PASTEURIZATION, STARTERS, CHURNS AND CHURNING, CREAM RAISING, &c. [J. GI.]

Buttermilk.—Buttermilk is the liquid portion left after churning milk or cream to butter. It will differ in taste and composition according to the nature of the liquid churned, but has in general a composition closely resembling that of skim milk. If the cream or milk used for churning is slightly sour, as is generally the case in this country, the buttermilk will contain lactic acid, a fact which may to some extent account for the health-giving qualities attributed by some to buttermilk as a beverage. The distinctive flavour and smell of buttermilk are, however, quite different from those of slightly sour skim milk, but it is not known to what causes these are due.

Buttermilk should contain less than 1 per cent of fat if the churning has been properly carried out, but it is more difficult to get the full yield of butter from sweet cream than from sour cream. This is one of the reasons why the use of a 'starter', or pure culture of a good lactic ferment, is so desirable in buttermaking. The use of pure ferments also gives a more uniform and better flavour to the butter. The

use of rich cream containing more than 40 per cent of fat for buttermaking will yield a buttermilk rich in fat; 25 to 30 per cent fat in the cream will yield the best results from the buttermaker's point of view. If the cream is too thick it is a usual practice to add water to it, and this will of course dilute the buttermilk. In the north of Scotland boiling water is sometimes added to buttermilk with the object of precipitating the proteid matter; the precipitated solid matter is called 'kirn' milk (a name which is given to buttermilk in the south of Scotland). The clear liquid from which the solid matter separates is called 'bland', and may be used as a beverage either in the fresh state or after going slightly sour. The proteid matter which is in suspension in buttermilk made from cream, partly consists of Storch's mucoid proteid, and may be removed by passing the buttermilk through a cream separator.

The following are compositions of buttermilk:—

Source....	From Sweet Cream.	From Ripened Cream.
Authority	Storch.	Veith.
Water ...	89·74 per cent	90·39 per cent
Fat... ...	1·21 ,,	0·50 ,,
Milk sugar...	4·97 ,,	4·06 ,,
Lactic acid..	—	0·80 ,,
Proteids ...	3·37 ,,	3·60 ,,
Ash ...	0·79 ,,	0·75 ,,

The water may vary considerably from the causes stated above.

The fat may vary from 0·15 to over 5 per cent. From the buttermaker's point of view it should be kept below 1 per cent. If much above this, it is probably due to one of the above-mentioned causes, or to neglect of attention to temperature in churning, to the use of too thick cream, or to too rapid churning. It may also be due to the mixing of cream of different degrees of ripeness, &c. Seen under the microscope, the fat globules are found to be in little groups. The fat may be determined in the same way as milk (see BUTYROMETER). Gravimetric methods will, however, give better results, the Gottlieb-Röse being a good and quick method. The milk sugar may be determined as in milk and whey, the optical method being preferable. The ash of buttermilk, which is very similar in composition to that of milk, may be determined by burning 10 gm. of the sample after the evaporation of the water for the determination of the total solids. [J. GO.]

Butter Pressers.—The attractiveness of butter, and therewith its market value, are commonly diminished by want of skill and taste in making up the 'rolls' which are offered to the public. Simple and inexpensive butter pressers, actuated by hand-power, do the work in a way that competes not unfavourably with the skill of most competent dairymaids, though these are needed, not only to actuate the 'pressers', but to give sundry finishing touches. [J. P. S.]

Butter Printer.—It may be questioned whether a mechanical printer of a pattern on half-pounds or pounds of butter that is to be supplied to customers is practically an advantage to buttermakers. Butter is now being sold more and more largely in the form of bricks, rectangular, but oblong in form, and these are decorated with great facility by the aid of the tips of 'Scotch hands', giving incisions intersecting each other across the upper side of a brick of butter. This simple and expeditious form of decoration is surprisingly chaste in design and effective in adornment. It throws the butter into bars of light and shade on the surface, and these bring out the butter's tint in a way that is at once surprising and attractive. See BUTTER, ORNAMENTAL. [J. P. S.]

Butter Separators. — The initial mechanical germ of the now ubiquitous cream separator was first exhibited at the International Dairy Show in Hamburg, in the month of March, 1877. This interesting germ, whose potentiality turned out to be altogether wonderful, and which was quickly followed by others containing developments of the initial idea, was a very simple and unpretentious construction consisting of two wheels about 2 ft. high, one of which was actuated at a greatly increased speed by the other, by means of a leather belt. The high-speed wheel had four glass test tubes attached to its pair of spokes, and as this wheel revolved at more than a thousand revolutions per minute, the heavier portion of the milk, viz. the aqueous, and caseous, and mineral—the creamless portion—was placed within the scope of centrifugal force and thrown to the outer end of the glass tube, whilst the cream—the lighter portion—remained at the inner end. The separation of the two portions—the cream and the creamless—was gradually accomplished in some ten to twenty minutes, and the division line was clearly seen when the machine came to a standstill. This demonstration focused a marked portion of the keen interest which the show called forth, and the present writer looks back over more than thirty years with undimmed satisfaction on the chance of seeing it that fell to his lot as delegate of the British Dairy Farmers' Association, which was then barely six months old.

Cream Separator for Hand or Machine Power

Where there are so many excellent varieties and even types of separators it is unnecessary to single out any one machine as being superior to the rest. It may, however, be cited as an interesting achievement that the Swedish (De

Laval) separators, which were of the earliest in the field in the 'seventies of last century, have kept their position in the front rank throughout the whole time, and keep it still.

Steam Turbine Separator

The separators of to-day—very different from those of the 'seventies—are marked demonstrations of perfection acquired by the application of the highest inventive and mechanical skill combined with persistent effort. Laval separators for hand-power range in capacity from 14 to 135 gal. per hour, and between these there are seven gradations. 'Power machines' run up in the 'Leviathan Turbine' to 440 gal. per hour of milk from which cream is perfectly separated.

Amongst salient and intrinsic advantages which accrue from the use of separators may be mentioned, briefly, these: (1) That practically all the cream is extracted from milk, which is not the case under any other method of separation. (2) This cream may be obtained immediately after milk comes in from the cows, and butter may be obtained, and, if need be, distributed to customers, before milk or cream has had time to get cold. (3) In this way perfectly fresh butter is derived from perfectly fresh cream, which in turn has been obtained from perfectly fresh milk. There are other advantages, but these are subordinate and need not be specified. See also SEPARATOR. [J. P. S.]

Butter Syringe.—'Squeegee' and syringe have been called for by the higher degrees of art which are now practised in buttermaking, and they do work that was formerly that of a ladle, a tin pannikin, a teacup, or any other subordinate vessel. The syringe is for washing butter while still in a granular state, when it has not been washed in the churn. The washing, however, is more easily and effectively done in the churn. The squeegee is for washing the inside of the churn; but here again the churn can be more effectively washed without the use of extraneous appliances, by simply putting water in and then revolving the churn a few times, changing the water once or twice, hot and cold. [J. P. S.]

Butter-workers. — Mechanical butter-workers so-named are far from being a modern innovation in the dairy, though it is quite impossible to say, even approximately, when they were introduced. Be that as it may, however, the hand of a dairymaid, as an instrument for the manipulation of butter in its preparation for the market or the table, can claim a much greater antiquity. There was formerly much difference of opinion as to which of the two was the better instrument for that special purpose. Some declared for the dairymaid's hand, because it was so soft and supple, and this, no doubt, is obviously true; but they of the other side declared that the hand was seldom cold enough not to injure by its warmth alone the delicate granular structure of butter at its best. Further than this, they said that a physiological process is constantly active in the human skin, during which carbonic acid is slowly evolved, which obviously could do the butter no good. And further, manipulation by hand was a rubbing process which, supplemented by the warmth of the hand, gave to the butter a greasy texture.

As the matter stands at the present time the consensus of practical and expert opinion is in

Butter-worker with Helical Roller

favour of the mechanical butter-worker, which after all is operated by the hand of the dairymaid. To those who are familiar with the ease

and celerity with which modern butter-workers with fluted rollers are operated, and the excellent way in which their work is accomplished, there is no room to question the wisdom of having these instruments in all progressive buttermaking establishments, be they large or little.

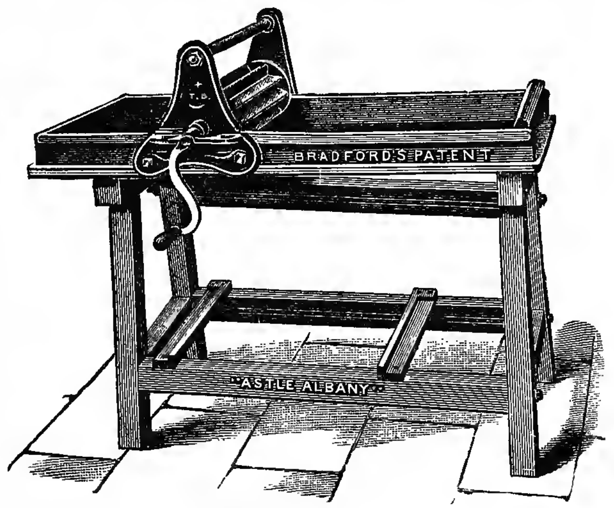
It is obvious that, between the churn and the market, butter must pass through two or three important processes, of which 'working' is fundamental and predominant in effect. And it will have been observed, in the dairy schools and elsewhere, that as the working is the foundation of all good manipulation of butter, a butter-worker performs the best part of the necessary process.

As it is taken out of the churn, dripping with the brine in which it has been floating, and from which it has taken up the salt it needs for flavour and as an antiseptic, the butter, golden in tint and granular in texture, presents a picture which is singularly charming to the eye. Could it be placed at once in this condition on everybody's table, with all the bloom and freshness, and the delicious flavour and aroma with which those who manipulate it are familiar, its popularity would increase to no small extent. But as this granular and loose condition is unsuitable for transit, the butter must be pressed into compact masses for convenience of distribution. And this consolidation is, beyond dispute, performed most effectively by the modern butter-worker, which has attained a high measure of excellence. The reasons for working butter are mainly these: to expel from it all undesirable and superfluous water, which may be taken to mean all water above 12 per cent; to compress the granules into a compact and cohesive mass; and to incorporate saline matter for preservation wherever dry-salting is still practised. The last-named reason is less cogent now than formerly, because brine is superseding dry salt to an extent which may be called general in the dairy schools, and in the larger and more advanced buttermaking establishments, whether private, co-operative, or commercial. The butter granules, once the operation of churning is completed, rest for half an hour in a bath of brine, which has replaced the water used in washing them, still inside the churn; and the butter takes up from the brine, during the time the bath continues, as much or as little of the antiseptic element as the dairymaid may desire. For all that, however, it is a matter of judgment—or of fancy—whether brining or dry-salting be practised.

To make butter compact in texture, and to get out of it all superfluous and visible water, requires the application of method, skill, and dexterity, which can only come of training and of natural aptitude for technical work. Not every-one who tries can acquire a high state of efficiency in dairy work, for there are degrees of natural aptitude. Yet, for all that, the difficulties of the dairy are not beyond ordinary ability to meet and overcome, if the pupil will only take sufficient pains. The whole thing depends, indeed, on honest application to work, and genuine effort to learn, and learn well, all that is necessary.

It is desirable, and indeed necessary, to churn cream at a low temperature in warm weather, say 56° F., in order to secure butter granules that are large enough—about the size of grains of wheat—in order that surplus water may be expressed without such an amount of working as will tend to make the butter greasy.

The adoption of mechanical butter-workers signifies that pressure, not friction, is desirable in the manipulation of butter. The preservation of granular structure in a pound of butter is, indeed, of high consequence, though the lump is well compacted together. And to this end the butter on the worker must be pressed but not rubbed.



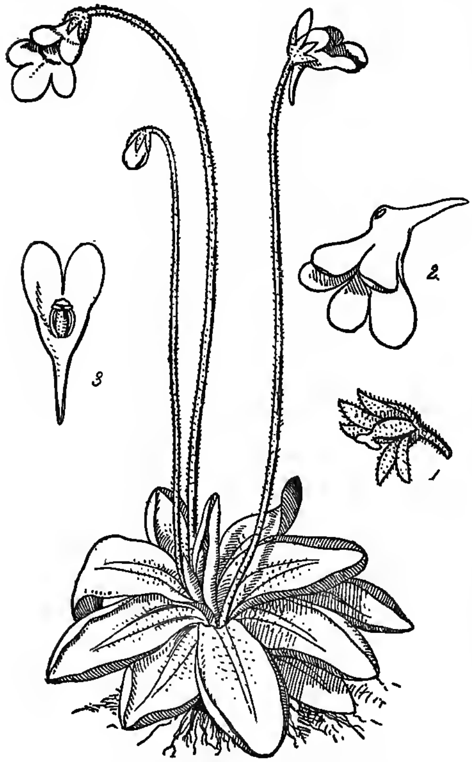
Butter-worker with Fluted Roller

The fluted roller passes over the mass of butter on the worker, each time doing something toward solidifying that which, to begin with, was in a state of loose granulation. This loose condition, which, inside the churn and on the worker too, presents so pleasing a picture, must be changed to one of compact solidity before the butter is fit for sale.

There is no difficulty worth the name in preparing a butter-worker to receive the granular mass from the churn. Well washed comprises the preparation in the manner taught at the dairy schools. Slowly used similarly comprises the method of operation. In careful hands the butter-worker is a most valuable and useful instrument, to all intents and purposes a *sine qua non* in a well-equipped dairy. [J. P. S.]

Butterwort (*Pinguicula vulgaris*, L.).—This common perennial bog plant is easily recognized by its rosette of thin succulent leaves spread out on the ground. The leaf is curved in at the

edges, and greasy to the touch. On the sticky surface are the remains of many insects upon which the plant has fed, for the Butterwort is an insect-eating plant, and the greasy matter on the leaf surface is the digestive juice which the glands of the plant secrete for the special purpose of trapping and digesting the insects. Like other insectivorous plants, the Butterwort does not live wholly upon insect diet: the insects are merely so much supplementary foodstuff to make good any deficiency of food manufacture, due



Butterwort (*Pinguicula vulgaris*)

1, Calyx and pistil. 2, Corolla. 3, Long section of Corolla.

to imperfect supply of appropriate food-making materials from the poor bog land on which the plant is growing. The leaves of Butterwort, if put into milk, act like rennet and curdle it. Linnæus tells us that in Norway and Sweden the warm milk of the reindeer is poured over the fresh leaves of Butterwort, and that after a day or two the milk becomes of a cheesy consistency. The product so made is considered a very grateful food. [A. N. M'A.]

Buttock.—The round fleshy prominences or rump of the bullock, and generally understood to embrace the hams above the hocks.

Butyric Acid, Butyric Fermentation.—There are two acids of the molecular formula $C_4H_8O_2$, but it is the normal butyric acid, $CH_3{\cdot}CH_2{\cdot}CH_2{\cdot}COOH$, which is found combined in the fat of milk, and also occurs in perspiration in the free state, and as ethyl butyrate in the oils of *Heracleum giganteum* and *H. Sphondylium*, and as octyl butyrate in the seeds of the parsnip. The acid is a liquid with a characteristic smell, which is specially marked in dilute solutions; the anhydrous acid has a sharp acid smell, but the disagreeable odour of rancid butter is not so marked. The acid which solidifies at –19° C. melts again at about –4° C. The boiling-point of the liquid has been stated to be 162·5° C. and its density 0·9746 at 0° C. It is difficult to prepare the pure anhydrous acid by distillation, the last traces of water being retained with great obstinacy; the liquid is also somewhat hygroscopic. It is soluble in all proportions in water, but is separated as an oily layer on saturating the solution with calcium chloride. Ether extracts it from aqueous solution.

The salts of butyric acid are all soluble in water, the calcium salt being more soluble in cold than in hot water. When butyrates are ignited they leave a residue of the carbonate of the metal, with the exceptions of the salts of silver and mercury, which leave metallic silver and no residue respectively.

It was the discovery of Pasteur in 1861, that the new organism which he had named 'vibrion butyrique' possessed the faculty of existing without air, which led not only to the foundation of his theory that 'Fermentation is life without air', but also to the more lasting idea that butyric fermentation is of a strictly anaërobic nature. It is now known that several organisms, some of which are capable of growing in the presence of air, are able to produce butyric acid as a product of their activity.

The word *Clostridium* was first used as a generic name by Prazmowski and given to two organisms, *Clostridium butyricum* and *Clostridium Polymixa*; the former of these is strictly anaërobic, while the latter is unable to exist in the absence of oxygen. Otherwise the morphology of the two organisms is the same. These organisms are motile rods about 1 μ in breadth; they form spores generally at one end, which give to the rods a spindle-shaped appearance. Gelatine is liquefied, and a scum is formed on the surface. A gas is given off from cultures which has the smell of butyric acid.

Other organisms are the *Bacillus butyricus*, which is found in milk and in turnips, &c.; *Clostridium fœtidum*, found in old cheese; *Granulobacter saccharobutyricum*, which is found on cereal grains, in green malt, groats, and flour, and gives rise to damage in badly-prepared distillery yeast mash. Glucose and even maltose are decomposed by this species, butyric acid, butyl alcohol, carbon dioxide, and hydrogen being produced. It does not liquefy gelatine. *Clostridium Pasteurianum*, isolated by Winogradsky from soil, is interesting not so much from its power of forming butyric acid as from its behaviour towards the free nitrogen of the air, which it fixes for the elaboration of its organic substances.

Conn's micrococcus of bitter milk also forms butyric acid, which is, however, not the cause of the bitterness produced, as butyric acid added to milk produces no bitter flavour.

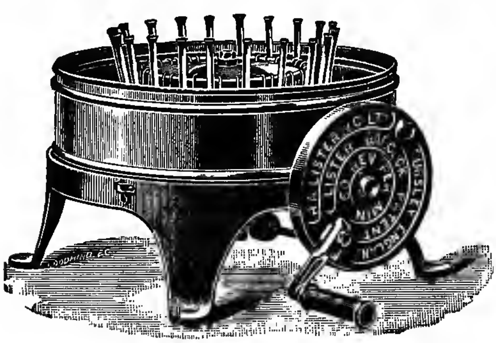
The chemistry of butyric fermentation varies with the kind of organism; various substances can undergo this type of changes as the result of the activity of micro-organisms, among which are hexoses (glucose, &c.), lactic acid and its lime salt, and probably also nitrogenous animal substances. Hydrogen and carbonic acid gas are generally given off during butyric acid fermentation, and frequently other substances are formed. Many of the organisms store up granulose, and are therefore stained blue with iodine. [J. Co.]

Butyrin.—Butyrin is the glyceride of butyric acid, that is, the three hydrogens of the trihydric alcohol glycerol are all combined with butyric acid:

$$\begin{array}{l} CH_2{\cdot}O{\cdot}CO{\cdot}C_3H_7 \\ | \\ CH{\cdot}O{\cdot}CO{\cdot}C_3H_7 \\ | \\ CH_2{\cdot}O{\cdot}CO{\cdot}C_3H_7. \end{array}$$

It is convenient to state that this substance exists in butter; but the fact that it cannot be dissolved out by means of alcohol, leaving the other glycerides behind, and also the fact that it cannot be distilled off under reduced pressure, make it highly probable that the mixed glycerides occur in butter fat (see BUTTER). The total butyrin calculated from the butyric acid in 100 parts of pure butter fat is about 3·8 parts. For saponification, &c., see BUTTER. [J. Go.]

Butyrometer.—Various mechanical methods have been devised for testing the percentage of fat in milk. The first of these was invented by Dr. S. M. Babcock, and depends on the solution of the casein and other solids of the milk, and the subsequent separation of the fat by whirling in a centrifugal apparatus; the fat is then read off in the graduated neck of the special flask in which the operation is conducted. The Lister-Babcock, which was the only machine of this kind on the English market, did not give a sufficiently high speed for centrifuging;

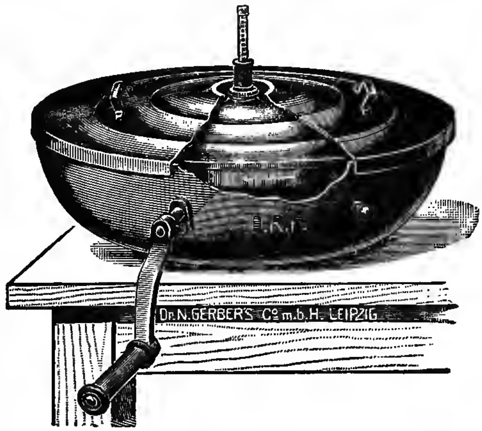


Lister-Babcock Butyrometer

as a result of this a correction had to be made, which, together with the fact that the flasks are only graduated in $\frac{1}{5}$ of a per cent, has resulted in this method being more rapidly replaced by its successors than in America.

Leffmann & Beam shortened the time necessary for whirling by the use of amyl alcohol and hydrochloric acid, but the bottles used were still the same shape as those used by Babcock, though smaller. A Beimling machine is used for whirling, and good results may be obtained, but, as with the Babcock, considerable experience is necessary to get the best results.

These methods, in common with others which were not so lasting, have now been largely replaced by a method introduced by Dr. Gerber,



Dr. Gerber's Butyrometer

of Zurich, which bears his name. The newest feature of this method is the butyrometer, or test bottle. This is a cylindrical flask, one end of which tapers off to a tube graduated in $\frac{1}{10}$ths of a per cent of fat, and terminating in a conical bulb. To the other end of the flask is fixed a short tube made to hold a rubber stopper. To perform the test the bottle is placed with the open end upwards, and 10 c.c. of sulphuric acid (sp. gr. 1·820 to 1·825 at 15° C.) is run into it; this is best done from an automatic measuring pipette; 1 c.c. of amyl alcohol (sp. gr. 0·815 at 15° C.) is now run down the side of the tube, and 11 c.c. of the well-sampled milk. The order of the milk and alcohol may be reversed, but in any case there should be no darkening by mixing at this stage. The butyrometers are now firmly stoppered, and then quickly shaken till all the curd is dissolved. They are now placed corks outwards in the disk of the centrifugal machine, and spun till all the fat has separated into the neck of the bottle. This takes about three minutes at 1000 revolutions per minute.

If the disk has not been kept warm, the bottles must now be placed in water at about 65° C. The fat, which should be high up in the neck of the bottle, is lowered by pulling out the stopper till the bottom of the 'fat' column is on a line with one of the long percentage marks; it is then read to the centre of the meniscus or curved line at the top of the fat layer; with very long and fast spinning the bottom limit of the meniscus may be taken. With separated milk the very top limit of the meniscus should be taken. The method should at the start be checked against gravimetrical methods, but even in the hands of those unused to chemical methods it yields results which do not differ more than 0·1 per cent of fat in an ordinary milk.

Two new methods have for their object the replacing of the sulphuric acid with a safer, cheaper, and more portable alkaline solution. One of these is called the Sinacid method, and the other Dr. N. Gerber's new 'Sal' method. In the latter the same-sized bottles are used, but 10 c.c. instead of 11 c.c. of milk; this is shaken with 11 c.c. of the Sal solution and 0·6 c.c. 'Butyl' alcohol. Good results may be obtained with these methods, providing the alcohol is very carefully measured; but by varying the alcohol the fat layer increases without any indication of a faulty result. These methods are not likely to replace Dr. Gerber's original acid method for general purposes. See also art. on MILK TESTING.

[J. GO.]

Buxus, the Common Box (*B. sempervirens*), a native of Britain, Box Hill in Surrey being largely clothed with it, is one of a number of species of evergreen shrubs or small trees, most of which are hardy in this country. In gardens the Box is known chiefly for its use as a low fence or edging, or as a border shrub. Allowed to develop, however, it will grow into quite a large bush, or even a small tree. There are numerous varieties of it, variegated, large and small leaved, dwarf and tall, and so on. It is one of the most accommodating of all evergreen shrubs, as it will grow in almost any position, can be transplanted with ease at almost any time, and it can be multiplied by means of cuttings or division to any extent. There is no better plant to form a screen than the Box, as it grows thick and is never broken by the wind. The wood is hard and very close-grained; consequently it is of considerable value commercially, boxwood being used for engraving, tool handles, thermometers, &c. In addition to the Common Box there are several other species which deserve mention on account of their usefulness in the garden. *B. balearica*, a native of Minorca, grows to a larger size than the common sort, has leathery yellowish-green leaves about 2 in. long, and is quite hardy in this country. *B. wallichiana* is somewhat similar to the last named, differing in having longer, narrower leaves, and a more upright habit. It is a native of the Himalayas. *B. japonica*, from Japan, resembles the Common Box, but it has rounder leaves, and forms a closer, more compact bush. For ordinary purposes, however, none of these is as useful as the Common Box. [W. W.]

By-employment.—A by-employment is an occupation carried on in addition to the main occupation of a person or family. The distinction between family by-employments and the by-employments of individuals must be observed. The term is not used when the several occupations are of equal importance in contributing to income. By-employments are desirable for individuals when their chief business does not absorb the whole of the week, or when the claim it makes upon their time is not evenly spread throughout the year. They are of value in adding to income and preventing idleness. Work on farms is not evenly spread throughout the year. Hence many people take to hop-picking in Kent and harvesting as by-employments. In early times, and to some extent in comparatively recent times, it was common for trades to be united with agricultural work. Certain textile operations were commonly brought into this association; but in many cases no doubt it was agriculture which was the real by-employment. The modern allotments movement is an attempt to re-create the system of by-employment in certain agricultural operations on a small scale. Family by-employments are more common. Thus the father of a family may be of one trade and his wife of another, and his children of yet another, and all may contribute to the family budget. The wages of the man are affected by the opportunities offered to his family of earning money. In some districts full family occupation is more completely afforded than in others. Generally speaking, industries are attracted to localities where there is a surplus of unoccupied labour in the normal family. In agriculture, however, owing to the scattered state of the population, the attraction of means of employment has been less than in urban districts. Partly to remedy this, societies exist for the encouragement of cottage industries. A by-employment, of course, is not necessarily carried on in the person's home. The value of family by-employments in preventing the early scattering of families should be noted; and also the danger associated with certain of them of children not being brought up to a definite trade at which alone a living can be made.

[S. J. C.]

By-products.—By-products are those commodities incidentally produced in the making or raising of some other article. The by-product is the one of least value. In economic terminology, commodities so related are said to be subject to joint supply. Examples are wheat and straw, mutton and wool, beef and hides. There is no doubt that straw would be called the by-product and not the wheat, but in the other cases the by-product might be the mutton or the wool, or again the beef or the hides, according to the main purpose for which the sheep or cattle respectively were intended. Towards the end of the 19th century much attention was devoted to the so-called recovery of by-products in manufacturing processes, and many important inventions were brought into use. We have as an example the by-product coke oven which turns out both coke and the other constituents of coking coal which were previously lost.

The theory of the value of by-products is difficult or simple according as a variation of the ratio of the commodities supplied jointly is supposed possible or not. If it is not possible, then the unit, the cost of and demand for which have to be considered, is a certain quantity of the main commodity and the quantity of the by-product invariably associated with this. When the amount of this unit produced is such that the cost of this unit equals the demand price for the quantity of the one commodity produced, added to the demand price for the quantity of the other commodity produced, the position of equilibrium is reached and the output and prices are determined. When, however, for a given unit of cost variable proportions of the commo-

dities supplied jointly can be turned out, the determination of values is not so simple. To give a general idea, all that we can say is that the output will be such that the normal cost equals the existing demand prices for the two articles, it being understood that for the unit of cost the ratio of the two things is that which yields the highest joint takings. Thus, if a farmer makes money from the meat and wool of the same sheep, and by feeding he can alter the value of the wool in relation to that of the mutton, he will be tempted to do so—and will be wise to yield to the temptation—to the enhancement of the value of the wool, if the demand for wool rises while that for mutton falls. To give another example, one of the important by-products of farming as a whole is manure. The scientific treatment of this manure, so that the utmost value may be obtained from it, and the settlement of the number and disposal of animals according to the cost of manure and the needs of different fields, are problems which repay the attention devoted to them. [S. J. C.]

Byres, or **Cow-houses.** — In Scotland the building in which the cows are kept is always called a byre, and the word—an old English one—is also in common use in the north of England and Ireland. The design varies according to district. In the feeding districts byres often have a row of stalls along the centre, with a feeding passage on the one side and another on the opposite one for milking and removal of the manure. This makes almost an ideal building when cost, convenience, and the health of the animals are taken into account, but unfortunately the design is not very common in the principal milk-producing districts. There the design most in favour is where the heads of the cows are towards the wall, and one passage behind is used for feeding, milking, and removal of manure. Unless special provision is made in byres with a feeding passage in front, so that the animals are prevented from leaning forward over their trough when being fed, they are almost certain at that time to pass some dung, which falls on the bed of the stall. If this is not speedily removed the animal may lie down on it and seriously soil her teats, udder, and hind quarters. With a fattening animal this is a matter of little importance, but with a cow yielding milk it is an incident which should as far as possible be prevented, as clean, much less healthy, milk can never be obtained from a dirty cow. It is for this reason that dairy farmers have preferred that their cows should stand with their heads to the wall, so that they cannot move forward, and so soil the bed of their stall.

In addition to its special suitability for a milking herd, the latter type has also the advantage that less space is required by utilizing the one passage for feeding, milking, and removing the manure of two rows of animals, and the expense of erection is correspondingly reduced. Another design for a double byre consists in having the heads of the cows towards the outside walls, but with a feeding passage in front alongside each wall, and a passage for milking and removal of manure between the two. From the point of view of cost, convenience, and health, this class of building is as economical as any of the others, but it requires a fully heavier roof. The worst design of any is where the cows are stalled with their heads towards a centre feeding passage, with two others on the outside for milking and cleaning. This design costs the same as the previous one, and differs little from it in regard to convenience, but is much less healthy for the stock.

The walls of all byres should be plastered from the ground to the roof, and the top of the wall should be beam-filled, so as to prevent dust from lodging there. Portland cement should be used for the plastering for the lowermost 5 or 6 ft., above which ordinary lime will do equally well. The cement plaster may be coloured red or pink, which saves painting or whitewashing, as it may be washed in the ordinary way. If the cost is not objected to, nothing looks so well as enamelled brick on the inside of the walls for the first 5 or 6 ft. from the ground. When done at the time of building the extra cost is not great; the saving afterwards is considerable, while the appearance of the building is very much improved.

The roof may be of any material generally used for the purpose. An open purled roof with iron crossbeams has the best appearance of any, and costs little if anything more than those with couples and joists. The next best for either appearance or utility is that where the joists are halfway up the couples. With an open purled roof all woodwork may be planed and varnished, but with any of the other patterns this is unnecessary, as they are just as well left rough.

The stall divisions may be made up with iron shoulder and heel posts with wood between; or they may be entirely of wood, or of thin flags, or of cement concrete. The divisions should not be less than 4½ ft. long and from 4 ft. to 4 ft. 3 in. high. If made of coloured cement, periodic washing will keep them bright and clean.

The stalls should be of a length which should correspond with the size of the animals intended to occupy them, as a stall which is either too long or too short invariably tends to more or less soiling of the hind quarters of the animal occupying it. It need not have a greater fall from front to back than 1 or at the most 2 in. The best material for the bed of the stall is probably any of the preparations of asphalt, made sufficiently hard not to be affected by the heat of the body. This material is a very good non-conductor of heat, and is therefore little liable to cause chills of the udder, bowels, or joints. Blue bricks set in cement are probably the next best material to use, but they are not always available in every district. Failing these, cement concrete may be used, and for the heel stones, or end of the stall bed next the manure channel, it is more serviceable than any of the other materials. For the smallest size of cows, such as Jerseys, Kerrys, and young Ayrshires, the stall should be from 6 ft. 9 in. to 7 ft. long

inclusive of the breadth of the trough. For Ayrshires of full size a stall 7 ft. to 7 ft. 3 in. will be sufficient, while Shorthorns will require from 7 ft. 3 in. to 7 ft. 6 in. For the smaller breeds each double stall should be from 6 to 6½ ft. wide, and for the larger breeds 6½ to 7½ ft. wide.

Some people prefer single stalls, and if these are adopted each should be from 4 to 4½ ft. wide, according to the class of cows intended to occupy them. The adoption of single stalls adds considerably to the cost of housing a certain number of animals, but it increases the area available for floor space, and part of the cost incurred can be saved in the height of the walls.

Separate troughs for each animal are to be preferred to a continuous one running from one end of the building to the other. These should always be of thoroughly glazed fireclay, white by preference for appearance, although brown is equally serviceable. Each trough should not be of a greater capacity than 3½ or 4 gal., and the angles between the bottom and sides, and sides and ends, should be rounded. Troughs 20 in. long by 16 in. broad and 8 in. deep will be quite ample for most circumstances. Where double stalls are used there should be a space of a foot or more between the troughs, which should be filled up with brick. This prevents a greedy animal from stealing its neighbour's food.

The angle along the whole top of the side of the trough next the wall, and the end next the stall division, should be filled up with cement to as long a slope as possible. This trifling precaution prevents food, dust, bits of straw, or filth of any kind from lodging there and ultimately causing a bad smell, while it at the same time materially assists in keeping the troughs clean and sweet. To further aid in this matter, the space between the troughs may be raised up like a double triangle, tapering to a point between the troughs, and sloping from the front to the back. This prevents any rubbish from lying on this space, while if the front part is sloped away it interferes neither with the cleaning of the trough nor with the animal when it lies down.

The manure channel is the most important detail, next to the length of the stall, in keeping the animals clean. It should not be less than 24 in. wide, and various authorities in different dairying countries are now advocating as much as 28 and 30 in. A narrower channel of greater depth does not serve the same purpose. The floor of the channel should be ½ in. lower at the side farthest from the cow's heels than it is at the other, and there should be a fall lengthwise of ½ in. for each cow. If the channel is made as suggested, it seldom happens that the manure from any animal covers it from back to front; consequently when any cow discharges its urine it at once runs to the low side of the channel, where it readily finds a clear passage away. If the manure channel is narrower than 24 in. it becomes blocked with dung from side to side, while all urine is collected in pools between the heaps of dung of the various cows. When any cow lies down, her tail drops into the urine, and later on she switches it not only over her own body but over those of the others near her. Owing to the heat of the cow's body this soon dries, and during the process of milking is shaken off into the milk, or settles down as dust from the air. In order to prevent this, the Dutch have a string tied to the lower ends of all the tails of their cows, which holds them up out of the dung and urine when the cow lies down. A *sine qua non* of an efficient cow byre is a manure channel designed as suggested. It need not exceed 8 in. in depth at the cow's heels, and 3 or 4 in. will be quite sufficient at the other side.

The cubic space necessary per cow is one of the questions on which there is great difference of opinion. If, however, anything like fresh air is to be supplied to our stock, the question resolves itself much more into one of ventilation than of cubic space. The minimum may, however, be fixed at something like 450 cu. ft. for the smaller breeds, and 600 cu. ft. for the larger ones.

The ventilation of a byre is the most important item of all its details, as it affects not only the health of the stock, but that of the consumers of the milk as well. Openings in the walls may for ordinary purposes be considered inlets, and those in the roof outlets, although at times neither deserve these names. For instance, in very heavy winds it will be found that all the openings on the exposed side are inlets, while those on the lee side are outlets. An inlet area of from 30 to 40 sq. in. should be provided for each animal, and in the ridge of the roof an outlet area of from 40 to 50 sq. in. per cow. Our winters are exceptionally mild compared with those of many countries, and even with such ventilation as is here suggested continually open, the byres will have a temperature of from 45° F. to 55° F. during all weather unless frost. If kept constantly ventilated, the byres will be quite comfortable for animals accustomed to them, and much warmer than byres usually are in Canada, Norway, Denmark, or other countries with severe winters. In keen frost the temperature will fall lower, and under such circumstances the ventilating openings may be temporarily partially closed. All ventilating openings should have some cheap and simple arrangement for wholly or partially closing them as may be desired.

The lighting of byres deserves more attention than it generally receives, if for no other purpose than to see the dirt. Each cow should be provided with at least 3 sq. ft. of glass, which may be either in the walls or roof. If in the latter, it should be on the north or east side.

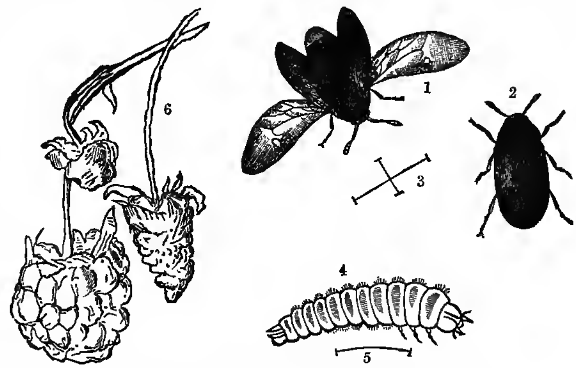
The floor space allowed to each animal also deserves attention, as where ample it contributes not only to the health of the stock, but also to the purity of the milk produced, and to convenience in attending on the animals. The area of the floor space is in great part regulated by the number and breadth of the passages, as the stalls and manure channels are almost fixed areas. If a feeding passage is used it should not be less than 3½ ft. broad, and the passage behind the cows should not be less than 4 ft.

wide. Such an arrangement will give at least 50 sq. ft. for the smallest breeds, and over 60 sq. ft. for the larger ones. In a double byre with only one passage for feeding, milking, and cleaning, it should not be less than 5 ft. wide, and will be all the better of being 6 or 7 ft. The advantage of space is more especially seen at milking time, for if a can is left on the passage to be filled with milk, it should be at such a distance from the manure channel that dung dropped will not cause some of its particles to be spattered over the can, and it may be into the milk. With a narrow passage this cannot be prevented. All double byres of this class should have a minimum floor space of 35 to 40 sq. ft. The passages may be laid with flag stones, blue bricks, or cement concrete. If the latter, it should have a roughened surface, as when smoothed with the trowel it becomes slippery if not kept well washed.

An ample supply of good water is an indispensable requisite for every byre. Sufficient should be provided not only for the animals to drink, but also for daily washing the floor of the byre. If it is desired to supply the cows with water in their stalls, the cheapest and one of the best methods is probably by a small trough covered by a lid in an opening in each stall division, and supplied by gravitation water. The cows soon learn to raise the lid with their nose, and having quenched their thirst, the lid falls down, and so keeps out dust and bits of straw, &c. See also art. BUILDINGS, FARM. [J. S.]

Byturus tomentosus (the Raspberry Beetle), the parent of the maggots often found in raspberry and blackberry fruit. It is a small reddish-brown oval beetle, about $\frac{1}{6}$ in. in length, and covered with a yellowish-grey down. The antennæ are slightly clubbed.

The beetles attack the bloom of the raspberry in May, destroying it wholesale, and laying their eggs in such of the flower buds as survive. The yellowish, brown-headed maggots devour the fruit, and grow to the length of about a quarter of an inch, and then seek some shelter on or near the bush in which to pupate. The winter is passed in the chrysalis state, and the beetles emerge the following spring to attack the new blossoms.



Raspberry Beetle (*Byturus tomentosus*)

1, 2, Raspberry beetles (magnified). 3, Natural size. 4, Maggot (magnified). 5, Natural length. 6, Infested raspberry fruit.

Treatment.—(1) Shaking down the beetles from the raspberry blossoms on to sacks soaked in paraffin, or on to tarred boards; but the beetles fly well, and the operation should be conducted early in the morning, or on a dull day. (2) Removing and destroying all old wood or loose bark, or any likely shelter for the grubs near the bushes. [C. W.]

C

Cabbage (as field crop).—In the article BRASSICA an account is given of the Wild Cabbage (*B. oleracea*, L.) and the various cultivated modifications which have arisen from it by variation and selection. In the cultivated varieties, usually spoken of as cabbages, the terminal bud of the plant develops into a large, compact 'head' or 'heart'. The genus Brassica is singularly plastic as regards its habits of growth. This plasticity exhibits itself in the large number of sub-varieties known to gardeners and farmers, most of which are characterized by their foliage. In some cases it grows freely apart, while in others it forms a close or dense heart, which latter may be considered as the peculiarity of true cabbages. The kales, or openheaded cabbages, although closely related, are usually considered apart. The internodes of all cabbages are remarkably close, and in all true cabbages the leaves are imbricated, or lie over each other, forming a compact mass. In some cabbages, as in the Savoy, the leaves are puckered more or less regularly over the entire surface, while in others they are smooth. The heart varies in shape, in some cases being flat on the top, in others conical in form, while in others it is purple or of varying shades of colour. Cabbages differ in size, in hardihood, and in the time required for their development, so that the number of varieties is large.

It is not necessary in this connection to treat at length of Cauliflowers, Borecole, Broccoli, Brussels sprouts, Majors, and other cultivated allies of the cabbage, still less of the turnip-rooted cabbage. Such treatment would lead us into botanical relations which are considered in separate articles, but they all bear out the fact already mentioned, that the cabbage is susceptible of profound modification under cultivation, and that new varieties may at any time be expected to appear. Of field cabbages there have been produced varieties which are suited to different kinds of soil and for different purposes in the economy of the farm. These are sufficiently

numerous to necessitate a description of the class, and the purposes for which they are required. Among them, nine may be selected as representing, if not all, most of the cabbages which enlist the attention of agriculturists. In considering these varieties it will be well to include the soil and situation for which each is adapted, and the peculiarities of their treatment, before entering upon the subject of cabbage cultivation in general. The largest member of the group is the Drumhead Cabbage, which may be divided into ordinary Drumheads and Savoy Drumheads, and again into Early and Late varieties. These cabbages are capable of growing to an enormous size, and individual specimens have been known to attain a weight of 70 lb. They are flat-topped, and compact in structure, and ought not to be planted closer than one per square yard. They are suitable for good, deep, strong soils, and often require a year to com-

Drumhead Cabbage

plete their career from sowing to final consumption. The Battersea is of similar type to the Drumhead. The remaining varieties are of smaller size and consequently may be set closer together, and are suitable for land of weaker character. Among these may be mentioned the Nonpareil, Early Sheepfold, Enfield Market, Imperial, Express, Oxheart, Large York, &c. Others are named after well-known seedsmen, as, for example, ——'s Imperial or ——'s Sheepfold, and many of them are well known to growers.

Cabbages are classed among the fallow and fodder crops. They occupy the same place in rotation as root crops, and are esteemed alike by sheep-masters, cattle-feeders, and dairy farmers. They are available during late summer, autumn, and early winter, and are particularly useful when grass is scarce in the hot months of the year. They are always to be seen as fodder in show yards, both in the sheep and cattle classes, and ram-breeders cannot dispense with them. Being mild in flavour, they can be given to cows on pastures in moderate quantities without tainting the milk, and the surplus may be sold for household purposes, often at profitable prices. Their cultivation is generally restricted to a small acreage, and they can be either eaten by stock folded on the land, or cut and carried away. They in either case quickly sprout again and develop several heads of small size instead of one, and may be folded a second or even a third time in certain cases. When cut, the lower three or four leaves are left; and when folded they must not be fed too closely if intended to stand for a second fold.

Although cabbages may be planted in spring as well as in autumn, the latter is the favourite time, and the first week in August is the best period for sowing the seed. If sown earlier they are apt to run up into flower stems, and if later the young plants encounter cold nights, and are exposed to the attacks of slugs, or are liable to be smothered with chickweed. It is not unusual to drill at once in the field, but the seed-bed is on the whole to be preferred. In choosing between these two methods, the following points are worthy of consideration. Well-selected cabbage seed costs from 3*s.* to 5*s.* per lb., and the cost of this item alone may well be set against that of planting-out. A cabbage seed-bed is in itself profitable, as surplus plants may be sold at from 6*d.* to 1*s.* per 100. Lastly, there is the advantage of being able to clean and prepare the field for the reception of the plants while they are developing in the seed-bed, a point of great importance after harvest. Instead of hurrying, and after all efforts finding the best season passing away, the seed is germinating and the plants growing so as to enable planting to be carried on through October and November. For these reasons the seed-bed is recommended, unless in exceptional cases. Seed-beds may be made in March or early August, but we take the latter as more in accordance with ordinary practice. It need not occupy much space, as $\frac{1}{20}$ of an acre sown with 1 lb. of seed will furnish enough plants for one acre of land. It is therefore unlikely that even on very large farms an acre of seed-bed will be required, and the space can usually be found upon a sheltered headland or other vacant space. The land should be dunged, ploughed, and well dressed down, and a bag of superphosphate scattered over the surface will stimulate the growth of the young plants. The seed may be broadcasted or drilled 1 ft. apart, and the former plan is quite as likely to prove successful as drilling, and will produce a larger number of plants. If sown about August 6th the seed quickly germinates, and the plants will be ready for transplanting in October and forward to December. Meanwhile the land intended to be planted is skimmed, cleaned, dunged, and ploughed to a fair depth, and so made ready for the reception of the plants. There are several methods of marking out the ground, and the most perfect is to set the cabbages at the points of intersection of cross lines. These may be made, after harrowing and rolling, with an ordinary drill having the coulters set at the required distance apart, *i.e.* about 18 in. These cross lines are not difficult to follow, and if the plants are carefully put in, the rows can be horse-hoed in two directions at right angles to each other, and present a geometric pattern in several directions. In some cases the plants

are put in with the help of a stretched line as in a garden. In others they are simply planted upon the unbroken ploughing, either in every alternate furrow or in every third furrow, *i.e.* at about 18 in. or 27 in. apart, without attempting a quadrilateral arrangement. In counties where the land-presser is used, the land is ploughed and pressed, and the plants are dibbled in along every other or every third press mark. In Bedfordshire, where cabbage cultivation is very thoroughly understood, care is taken to avoid doubling the taproot by shortening the fibre. The roots of the plants are also dipped in a bucket containing superphosphate suspended in water, and each plant is 'heeled' in by the planter as he proceeds. Each plant should be tightly or securely planted, the practical test being that it must not come up if pulled at the extremity of a leaf, but resist the pull to the extent of breakage. A man is reckoned to put in 5000 plants a day if brought to him and thrown out in front by a boy, who will supply three or four planters, and the cost of planting is about 10*s.* per acre.

Cabbages are adapted for an extensive series of soils. They attain the heaviest weight per acre upon heavy land well dunged and liberally topdressed. Twenty loads per acre, ploughed in in early autumn, is not an overdose for this gross feeding plant. Nitrate of soda dropped around each plant in April by finger and thumb produces a very beneficial effect, but must be accompanied with horse and hand hoeing. The after-cultivation consists in filling in the gaps from the seed-bed and flat-hoeing the entire surface. This is followed by horse hoeing, either in one or two directions, according to the system pursued in planting. All weeds must be kept down by a second hand hoeing between the plants, and a second or even a third horse hoeing between the rows. Growth is rapid and completely covers the surface, and the earlier and smaller varieties are ready for folding or carting off in July. Drumhead cabbages are similarly treated, but are set a yard apart each way, and continue to grow until winter sets in. After the first folding or cutting, a plough without a mouldboard should be run between the rows and followed with the horse-hoe, and the stalks will quickly break out into fresh foliage and develop small heads which may be folded a second time, and the land may then be brought into wheat or spring corn.

Cabbages are especially suitable for clay soils when planted out in autumn, because at no period of the year does this class of land work easier or more kindly. The seed-bed allows of the field being well prepared after harvest, and planting does not involve the treading of horses. Such crops are ready for consumption in late summer and early autumn, or at a period when the treading of sheep is not injurious to their soils. The cabbage is also widely cultivated on lighter soils for sheep, and if well manured there is no difficulty in growing a full crop.

In nutrient properties cabbages are inferior to swedes but superior to white turnips. They contain 90 per cent of water, 1·6 per cent of albuminoids, 5 to 7 per cent of carbohydrates, 0·8 per cent of ash, and no fat. In this latter item they resemble the leaves of swedes and turnips. The bulbs of turnips and swedes are of very similar composition but contain 0·2 per cent of fat, so that there is little appreciable difference between cabbage and 'turnips'. The

Conical Cabbage

value of the crop in a great manner depends upon its being ready for consumption at a time when grass and other succulent foods are scarce, and this is especially the case in dry summers.

Besides solid-headed cabbages there are several allied crops which deserve attention, among which Sprouting Broccoli and Thousand-headed

Savoy Cabbage

Kale may be named. The latter is unquestionably a variety of cabbage, but deserves separate notice as it is recognized as a distinct crop.

The chief insect enemies of this crop are the root fly (*Phorbia brassicæ*), the cabbage moth (*Mamestra brassicæ*), the cabbage aphis (*Aphis brassicæ*, see under art. APHIDES), and the white butterfly (*Pieris brassicæ*). The reader will find

descriptions of these insects in the arts. on PHORBIA, MAMESTRA, &c. [J. WT.]

Cabbage (Garden).—While the cabbage will grow in almost any kind of soil, it can only be produced in perfection in soil that is of good quality and well manured. In the market gardens near London, where enormous quantities of manure are used, the best-quality cabbages are grown. In addition to farmyard manure, guano, superphosphates, nitrates, and wood ashes are sometimes applied with advantage. The free use of lime is necessary to keep down the disease known as finger-and-toe or anbury (see FINGER-AND-TOE).

Seeds are sown about the end of February for plants to be used in August, a second sowing being made a month later, and a third in May. These sowings should be of varieties that heart quickly, such as All Heart, Ellam's Early, Tender and True, and Cocoanut. It is usual to make a sowing in autumn, say the middle of August, for plants intended to furnish a supply in the following late spring and early summer. There are varieties known as non-bolters which are preferred for autumn sowing, the drawback to the cultivation of cabbages for early summer being their proneness to run to flowers (commonly known as 'bolting') instead of forming heart. When the seeds are sown in drills, and the seedlings thinned to the required distance, transplanting being thus avoided, there will be a smaller percentage of bolters than when the seedlings are transplanted.

In the warmer parts of the country a sowing for a supply of spring cabbage is made a month later than in colder situations; in Scotland this sowing is made in the middle of July. The varieties recommended for autumn sowing are Battersea, Offenham, and Favourite.

Colewort or Kale is a tall, loose-headed cabbage which is cultivated for a supply of winter greens. The seeds are sown in June, and the plants set out usually on ground that has been cleared of potatoes. The Savoy Cabbage differs in having the leaves crinkled or bullate. It is usually very solid in heart and is exceptionally hardy, being rarely injured by the severest frost. It requires the same treatment as the ordinary cabbage. There are several well-marked forms, some with quite small hearts, which mature quickly, while others are large, and are at their best in midwinter. Red Cabbage is a form of the common cabbage with the leaves folded very tightly over each other, forming a solid heart. It is used only for pickling. Seeds are sown early in spring, as the plants are slow in maturing. [W. W.]

Cabbage.—Fungus Diseases.—Cabbage, Kale, Brussels Sprouts, Kohlrabi, Cauliflower, and all the cultivated varieties of the wild cabbage (*Brassica oleracea*) are subject to the attacks of the same parasitic fungi, so that a disease on one variety may be conveyed to any of the others. From crops of the cabbage tribe they may also be transmitted to one of the varieties of Turnip or Rape, or to any species of the order Cruciferæ, such as Radish, Horse Radish, Mustard, Cress, Wallflower. Common weeds like Charlock and Shepherd's Purse have also been observed to act as nurses. Only a few of the parasitic fungi of the Cruciferæ are dealt with here; others are described under TURNIP.

DAMPING-OFF OF SEEDLINGS.—Overcrowding in seed-beds favours excessive moisture and hinders free circulation of air. One of the most frequent fungi favoured by these conditions is *Pythium debaryanum*, easily recognized by its mode of attack. This fungus begins its growth on the soil, and the mycelium attacks seedlings where they emerge from the soil; this place becomes discoloured and soft, so that the plants fall over. The disease spreads rapidly from plant to plant, and the seed-beds become dotted with patches of decaying plants. Pythium belongs to the order Phycomycetes (see FUNGI); it produces motile spores which germinate at once, and sexual spores which rest in the soil. The life-history is very similar to that of the tree-seedling disease (see BEECH).

Treatment.—Reduce moisture by giving ventilation and light, and thin out the beds by transplanting the stronger seedlings. The soil used for raising seedlings should be fresh and clean; risks will be reduced if it is sterilized by heat or by steam.

LEAF MILDEW.—When the growth of young plants is retarded by dull, unfavourable weather, or when a moist, warm time succeeds a dry period, various forms of white mildew may give rise to either a putrefactive rot or to a white coating on the leaves. Where the foliage has to be used as food, as in cabbage, the use of Bordeaux mixture is not advisable, and the best treatment is to keep up a steady growth of the crop by suitable cultivation and manuring.

ROOT DISEASE.—This is frequently due to insect pests, but it has also been traced to fungi. Of these, finger-and-toe is common. This organism can be recognized by the knotted thickenings on the roots, and as these are left in the ground when the cabbage crop is removed, they may serve to infect succeeding crops of turnips or other crucifers. The best treatment is by lime and by suitable cultivation. See FINGER-AND-TOE.

STEM-ROT.—This disease has recently received considerable attention (see Journal of the Board of Agriculture, December, 1903, p. 314). It is generally caused by a bacterial form (*Pseudomonas campestris*), the attack being recognized by a soft brown rot in the stem and roots, extending up the veins of the leaves, which become rotten. Injuries caused by slugs, snails, and insect larvæ are said to provide wounds for the entrance of the bacteria, and in one case under our observation slugs were certainly abundant, and almost every plant of cabbage was rendered useless. The control of this disease becomes therefore a question of suppressing the animal enemies; it is also advisable to avoid growing cruciferous crops too frequently on land liable to this disease. [W. G. S.]

Cacao (Cocoa), a name (of native American origin) given to the seeds or 'beans'—so-called—of *Theobroma Cacao*, from which the well-known chocolate is prepared. The Cacao plant is a small tree, or perhaps rather large bush, which belongs to the Sterculiaceæ and is indi-

genous to Central and to the northern states of South America. It is now cultivated in many tropical moist countries, the European supply coming mainly from Venezuela, Ecuador, Brazil, Trinidad, Grenada, Ceylon, Jamaica, and W. Africa. There are said to be many cultivated races, which have been grouped under two sets, the *Forastero* and the *Criollo.* In Guatemala is cultivated *Theobroma speciosa*—the Tabasco Cacao (on the Atlantic slopes), and the Soconusco Cacao (on the Pacific slopes). The Spanish invaders of South America in 1513–23 found the seeds being used in place of money. Their great dietary value was investigated by Benzoni in 1550. They were first mentioned in connection with England in 1659, but their immense popularity, both in the form of a beverage and of confections, may be spoken of as a significant feature of the 19th century. The tree attains a height of 15 to 30 ft., has many spreading branches, but no central stem. Its leaves are large, broad, oblong, attenuated, and remarkably thin. It produces numerous small solitary or clustered flowers on the older naked branches. These are followed by conspicuous pendent fruits that seem to nestle under the shade of the wide-spreading dome of foliage, and are often crowded around the stem like those of the papaw tree. The fruits (pods as they are generally called) become 6 to 9 in. long and 3 to 4 in. in diameter. They are five-celled, and more or less pentagonal in outline, but marked by ten furrows and warted ridges (due to the growth of the seeds within). When ripe, they have a leathery, pale-coloured, thin dry rind, and contain forty or more large seeds embedded in a pulp. The pods may thus be readily collected, and two, being cut from the stem, are struck violently together, thus causing them to burst open, when the seeds may be at once removed, and the empty fruits left on the ground to serve later as manure. The seeds are about 1¼ in. long and nearly ¾ in. thick, and when cut open, the seed-leaves are revealed as filling the entire space, and as large, thick, crumpled-up, creamy-white and oily structures enclosed by a thin seed-coat, which is covered externally with mucilage.

The Cacao is raised from seed, and for this purpose the largest and best fruits fully ripe should be selected. If stored for a week or ten days the seeds begin to germinate within the fruits, and may be either planted in a nursery or at stake in their permanent positions. If the former course be adopted the seeds may be sown 4 by 6 in. apart, when in a couple of months or so the seedlings will be 1 ft. in height and ready for transplanting. It must be remembered that Cacao forms a pronounced and deep-growing taproot. It is therefore necessary not only to select a rich open soil for the plantation, but also to exercise the greatest care in transplanting the seedlings. On this account many planters prefer to sow the seeds in flower-pots consisting of short joints of bamboo packed into beds within the nursery and sunk below the surface. When the seedlings are ready for transplantation a stroke of the knife splits the bamboo, and the decomposition that soon follows allows of the ready escape of the roots. If sown in their permanent positions, four or five seeds are separately deposited a few inches apart and around the stake. The largest and healthiest-looking plant of the set is left, and all the others either destroyed or transplanted to fill vacancies. In good deep soils the plantation may be lined 15 to 20 ft. apart; on poor soils or in hilly regions (where the plants will not grow to a large size) the lines need only be 10 to 15 ft. apart. Closer than these distances will be found greatly to curtail fruitfulness, and if the plants do not utilize the ground thus assigned to them, the plantation may as well be abandoned.

The Cacao is a delicate plant, in its earlier stages at least, and may call for liberal watering and the provision of temporary shade. In fact, should the locality be subject to periodic storms in a fixed direction, it will be necessary to provide permanent wind hedges. The temporary shade is best afforded by growing bananas (plantains) in sufficient numbers with the Cacao plants. These give a temporary return, and if properly tended will afford the desired shade without doing any injury. But many planters prefer to use a species of Erythrina, or some other leguminous plant, from the belief that such not only supplies the shade sought, but permanently improves the soil. Weeding, pruning, and manuring are operations that call for the most earnest attention. In these respects, in fact, Cacao may be regarded as in no way different from coffee. The objects in pruning are to ensure the required light and air permeating to the fruit-bearing parts, and to pro-

Cacao Plant

A, Old shoot bearing clusters of small flowers, and fruits in all stages of growth. B, Young leaf shoot. C, Ripe fruit, showing warted ridges. D, Seed, showing crumpled seed-leaves. E, Flower, with its concave-spathulate petals.

vide and foster the necessary clean, well-formed wood essential to a liberal and continuous production of flowers and fruits.

The plants come into bearing in the fifth year, but do not yield their full crop much before the seventh or eighth. They may give fruits all the year, though there are two special seasons, namely, from April to June—known as the Easter crop, and from November to January—the Christmas crop. The yield depends greatly on soil, climate, and treatment, but may be said to range from 1 lb. to 10 lb. of dried seeds per tree a year. The fruits must not be roughly torn from the stems, since thereby much injury might be done to the 'eyes' or buds, upon which next year's flowering depends. They should be cut off with the stroke of a sharp knife, and as near to the base of the fruit as possible. It is customary to pile them in little heaps under the trees for a day or so, to allow of complete maturity before removal of the seed — 'the beans or nibs' as they are now designated.

The nibs are conveyed to the fermenting house, and on their subsequent treatment much of the success of the industry depends. Sweating may be done in boxes or in specially constructed air-tight rooms. By the former process the nibs are packed within the boxes, and over the top are thrown plantain leaves, cloth, and boards, and the batch is left to ferment for three days. The nibs are then removed, repacked into other boxes, and once again left for three more days to complete fermentation. By the latter process the nibs are spread on the floor and the house shut up to allow fermentation to take place. After the third day they are turned over into new positions, the object being to ensure uniformity of action. The moisture, warmth, and confinement of the air generate fermentation, the beans swell, carbonic acid gas is evolved, and a change accomplished in the nature of the nutritive matter contained within the seed-leaves, a large proportion now becoming soluble. The beans change to the well-known dark colour, and become highly charged with the characteristic odour. Sweating having been completed, the beans are brushed or rubbed between the hands or over rough cloth to remove the seed-coats and other adhering impurities, and are then dried ('cured' as it is called). This is accomplished by exposing them to the sun for a few hours, and guarding them from rain by day and dew by night. In some cases partial sweating is again resorted to, between rubbing and drying, so as to ensure uniformity, and to prevent a too rapid drying. Each succeeding day the beans are kept longer in the sun, until drying has been completed. In Ceylon, which produces the finer grades of nibs, a washing is resorted to, so as to remove all dirt and mucilage, between the sweating and the drying. In other cases, inferior nibs are artificially coloured with a special red mud, the process being described as 'claying'. The Caracas Cacao is said to be often largely so coloured. The cured nibs are roasted, ground to a flour, and flavoured with sugar, vanilla, &c., in the production of chocolate.

The imports into Great Britain of what are described as 'raw cocoa' have ranged from 50 to 60 million pounds during recent years, and have been valued at 1½ million pounds sterling. The chief sources are the British West Indies, Portugal (really the W. African islands of San Thomé and Principe), France, Ceylon, Ecuador, Brazil, Germany, and British West Africa. The returns of 'cocoa butter' may to some extent record the traffic in the butter obtained from the Cacao seeds, but to a very much larger extent the butter of the cocoanut palm. [G. W.]

Cacciocavallo Cheese.—This is an essentially Italian cheese, equally so as the Parmesan or the Gorgonzola; but it differs from them in general character quite as much as they do from each other, though in hardness of texture it somewhat resembles the Parmesan. The rennet used to coagulate the milk is from the stomachs of young goats and lambs, dried as they are, without washing. When used, they are cut into small pieces, wrapped in a piece of linen, and suspended in the milk until coagulation occurs. The coagulum is broken up to allow the whey to separate. A portion of the whey—nearly all of which has been drawn off—is then heated over a fire and poured in a boiling state over the curd, and induces fermentation. The critical part of the process is that of putting an end to the fermentation, by cooling, in half a day's time. The curd is next immersed in a vessel containing boiling water, after which it is drawn out in long thin strips, which are formed into a circular mass by winding round and round. [J. P. S.]

Cactus.—The Cactus family comprises a number of genera found only in tropical countries. A few of them, however, grow at such altitudes as to be sufficiently hardy to be cultivated in sheltered positions in the open air in British gardens. The most suitable position is on a south border backed by a wall, preferably that of a heated building, and they should be planted in loose soil with which old mortar rubble has been mixed, and protected in winter by throwing a covering of some kind over them when frost is severe. There is a representative collection of these hardy Cactuses in the recesses formed by the buttresses of the Palm House at Kew. They include species of Opuntia, Cereus, Echinocactus, and Mammillaria. [W. W.]

Caddis-flies. See PHRYGANIDÆ.

Cade-lamb, a lamb which is brought up by hand.

Cadma, a term applied to the smallest of the pigs which a sow has at one farrowing.

Cadzow Cattle.—The Cadzow cattle form one of the herds of Wild White Cattle still surviving in Britain. They are kept on a part of the estate of the Duke of Hamilton in Lanarkshire. See WILD WHITE CATTLE.

Caerphilly Cheese.—This is the one Welsh cheese that may be distinctively regarded as a special dairy product of the Principality. It is a thin, flat, circular cheese, about 2 in. thick and some 8 or 10 in. in diameter. It lays no claim to distinguishing merit, and is otherwise wholly unpretending. It is innocent of any

special process of manufacture, nor does it seem to be always a cheese made from unskimmed milk. It is in demand chiefly amongst the mining population of the south-eastern counties of Monmouth and Glamorgan as a cheap, wholesome, and nutritious food suitable for men accustomed to hard work. [J. P. S.]

Cæsarian Section.—'Cæsarian section' is the name given to artificial delivery through the abdominal wall of the mother, and is resorted to in extreme cases, where the value of the young is deemed greater than that of the parent, and natural birth is impossible. It has usually to be performed under circumstances which preclude perfect asepsis, and is commonly fatal to the mother, although the offspring has a moderate chance of survival. The animal should be anæsthetized by chloroform, and the abdominal wall rapidly incised by one clean wound, the womb being next opened and the fœtus lifted out. In the case of dogs and cats, and occasionally sows, the life of the parent may be saved. The severity of the operation, and the shock resulting from it, is not so frequent a cause of death as septic poisoning by the liberated matters in the uterus. The smaller animals may have the uterus with its contents lifted bodily outside, and the neck ligatured before severance, thus reducing the risk of blood-poisoning. The size and weight of the gravid uterus in mares and cows makes this wellnigh impossible. [H. L.]

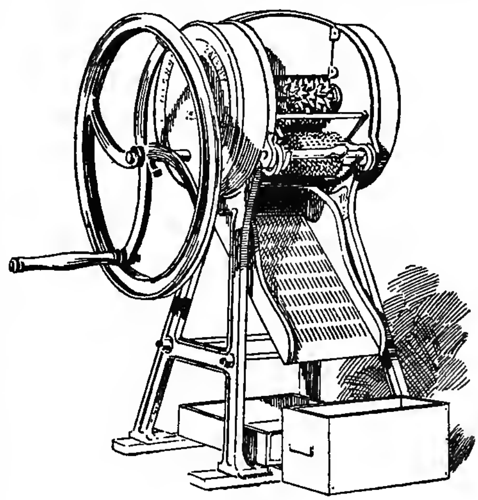
Caffeine or **Theine** occurs in the leaves and berries of the coffee tree: the berries contain from 1·2 to 1·3 per cent.; in tea leaves, which contain from 2 to 4 per cent; and in the seeds of the kola tree, which contain about 2 per cent. Small quantities of caffeine are also found in cocoa and other plants. Caffeine is used in medicine as a nerve stimulant. It consists of long silky needles, and can be dissolved out from the plant organs containing it with water, in which it is slightly soluble. It has a feeble bitter taste, is a weak base, and forms salts with strong mineral acids.

The stimulating action of tea and coffee is largely due to the presence of this substance. [R. A. B.]

Cage Gate (sometimes called 'Kissing Gate') is defined as 'a small gate traversing between two shutting posts, and subtended by a small angular space enclosed with paling'. It is comparatively inexpensive in construction, yet it is especially convenient for the transit of infirm or careless persons, as it cannot be left open so as to permit the passage of a cow or sheep.

Cainozoic (also written Cænozoic and Cenozoic), a name for the rocks and the geological era in which the later faunas ('recent life') appear upon the globe. The included subdivisions are also known as the *Tertiary* systems. The appearance of man in Post-Pliocene times is usually held to set a limit to the Cainozoic era, and to open the Quaternary era, in which we still are living. [G. A. J. C.]

Cake-breakers. — Cake-breakers are necessary because animals cannot properly digest hard cakes such as linseed, cotton, and rape cakes unless they are finely broken; moreover, large pieces of cake are very liable to produce choking because of the inability of animals to swallow them. The ordinary cake-breaker consists of a frame carrying a pair of adjustable, parallel, horizontal, notched rollers working towards one another sufficiently close to break the cake. It is undoubtedly advantageous to employ two sets of rollers, a finer one below the coarser, so that the cake may be more finely reduced than is ordinarily the case; this is especially marked in the case of hard decorticated cotton cake, and even of softer samples,



Nicholson's Cake-mill

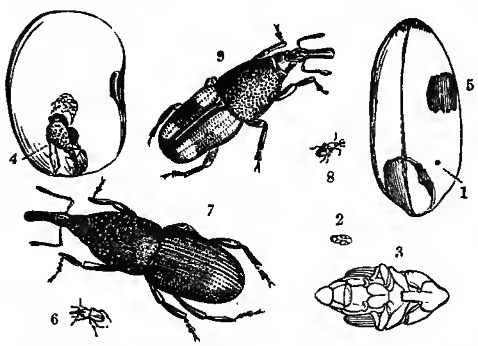
as decorticated cotton cake frequently contains liver-coloured lumps, almost stone-like in hardness, which prove dangerous to live stock consuming them. It is indeed safer that these cakes be reduced to a meal, to ensure which they are crushed in a grinding mill. [W. J. M.]

Cakes (compound). See FEEDING STUFFS.

Calandra granaria (Granary or Corn Weevil: fig. 6 natural size, 7 magnified) is one of the most destructive insects that live amongst stored corn and malt. About April, or as soon as the weather is warm enough, the beetles pair, after which the female burrows into the corn heaps, and pierces a minute hole (fig. 1) with her rostrum in a grain, laying an egg in each until they are all deposited, which often is not until the approach of autumn. The maggots soon hatch, and feed upon the contents of the grain until the husk and germ alone remain, each grain supplying sufficient nourishment to bring its inhabitants to maturity, when it changes to a pupa (fig. 2, magnified at 3), and in about six or seven weeks from the time of pairing the perfect weevil is hatched, and eats its way out of the grain (fig. 4 shows a kernel of maize magnified, with the beetle inside). Unless the weevils are seen walking over the corn, it is difficult to detect their presence until they have been at work for

some time, and the holes of their exit become visible in the empty grains (5). On throwing a handful, however, upon water, their operations are manifested by the floating kernels. The corn weevils cannot endure cold, being natives of more southern regions; and, consequently, they desert the corn heaps on the approach of winter, to seek a warmer abode in the chinks of walls, crevices in beams or floors, &c., so that, if the old stock of corn be then removed, unless the weevils be ejected or destroyed, they are ready in the spring to commence upon fresh samples of any sort of grain, although they give the preference to wheat, barley, and malt. Maize, however, sometimes suffers greatly from their inroads, as well as oats.

The eggs are extremely minute; the maggots have no feet, are white and fat, with horny



Granary or Corn Weevil (*Calandra granaria*) and Rice Weevil (*Calandra oryzæ*).

ochreous heads, armed with little jaws; the pupa is of a transparent white, disclosing the members of the future weevil through its clear skin.

The beetle is one of the family Curculionidæ (Weevils), and its scientific name is *Calandra granaria*. It is nearly two lines long, smooth, shining, a little depressed, and varies from a dark chestnut to a pitchy colour; the head is furnished with two small black eyes, and narrowed before into a proboscis, which is shortest and thickest in the male; at the apex of this are placed the jaws and mouth, and before the eyes it is a little dilated, where the slender elbowed antennæ are attached: these are nine-jointed, and terminated by a little ovate club; the thorax is large, and narrowed in front to unite with the head; it is coarsely and thinly sprinkled with oval pits; the wing cases are short and oval, with eighteen deep and punctured furrows down the back, but the insect has no wings; the six legs are short and stout; the shanks are hooked at their extremities; the feet are bent back in repose, being four-jointed, the third joint heart-shaped, fourth furnished with two claws.

C. oryzæ, the rice weevil (figs. 8 and 9, nat. size and magnified), is another species not less destructive abroad, especially to the rice of the East Indies, to wheat in the southern states of Europe, and to the corn of Africa. Fortunately our climate is too cold for them to breed in Britain in any numbers, except in steam mills, although the beetles are very common inhabitants of wheat, rice, &c. Its transformations are similar to those of *C. granaria*, but the weevils are rather shorter and not so smooth; they vary from an ochreous or golden colour to chestnut or pitchy, according to the age; the eyes are black; the thorax is rough, with strong crowded punctures; the wing cases are broadest at the base, with rows of punctures down the back, forming ridges; in the dark specimens, four large paler spots are very visible on the back, two at the base, and two towards the tail. It has a pair of ample wings, folded beneath; the legs vary but little from those of the foregoing species.

A minute greenish wingless insect, allied to *Meraporus graminicola*, infests the maggots or pupæ of these weevils, and preys upon them. Corn should be stored in bulk, as the beetles will not work far into a mass. The corn may be cleared of weevils by fumigation with disulphide of carbon or kiln-drying. Disulphide of carbon is used at the rate of 1½ lb. to every 100 bus. of grain. It should be placed in a dish on the top of the grain and left for one or two days, the outside air being excluded. It requires care in using, as it is highly inflammable; it must not be used near any light or live electric wire. The kiln-drying should be at a temperature of 140° F. for at least two hours. [J. C.] [F. V. T.]

Calathus cisteloides (Ground Beetle), a small ground beetle, varying from ¼ to ½ in. long; black with reddish-brown legs and antennæ; no wings, or at least very imperfect ones; the thorax is narrowed in front, sinuate behind, and the posterior angles rounded off. This beetle attacks the ripe and ripening fruit of the strawberry and often does much damage. It is a nocturnal feeder, and hides in the ground during the day, and under the straw between the rows of plants. It may be cleared from a bed of strawberries by placing jam pots or pudding basins in the ground, baited with meat or lights. [F. V. T.]

Calcareous Grit Series, a series of strata of Upper Jurassic age, developed along the back of the Cotswold range from Dorsetshire to Yorkshire, and occurring between the Oxford Clay and the Kimmeridge Clay. These strata thus come within the Corallian stage of the classification now adopted. The beds known as 'calcareous grits' are typically calcareous and ferruginous sandstones, but the term has been used to include oolitic limestones. (See H. B. Woodward, Mem. Geol. Survey, Jurassic Rocks of Britain, vol. v, 1895, p. 70.) The series yields a light loamy soil, sometimes coloured a strong red by iron oxide, and often inclined to be too stony. [G. A. J. C.]

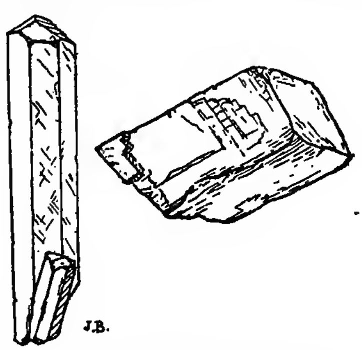
Calcareous Soil.—A calcareous soil is one which contains a relatively high percentage of lime, which may be present in various combinations (see CALCIUM COMPOUNDS IN SOIL). The relationships of calcareous to other types of soil are considered in the article on soil (see SOIL).

Calcareous Tufa, a deposit of carbonate of lime on the surfaces of rocks, plants, or other

objects, where water containing this substance (as a bicarbonate) in solution flows over them and at the same time is evaporating. Crusts of calcareous tufa may also be formed on the surface of the ground during dry seasons in warm climates, by the capillary rise of water from below charged with carbonate of lime. Thick layers are thus formed, for instance, on dry stony soils in the north-west of Cape Colony. Water trickling out through the crevices of limestone often coats with a white friable crust of tufa the mosses and moisture-loving vegetation that grow beside the springs. On a larger scale this material develops into the rock known as *Travertine*. It has been pointed out that in many cases the plant-life itself helps in the removal of the carbonate of lime from solution, either by the withdrawal of carbon dioxide from the water during the processes of vegetable growth, or, in the case of certain algæ, by the deposition of calcium carbonate in the cell-walls of the plant. [G. A. J. C.]

Calceolaria.—A genus of Scrophulariads distinguished by the peculiar form of the flowers, which are two-lipped, the lower lip being inflated, somewhat resembling a shoe. In gardens there are four sections cultivated: (1) half-hardy shrubs, represented by *C. Pavoni* and *C. violacea*; (2) greenhouse pot shrubs, popularly known as herbaceous; (3) bedding calceolarias; and (4) Alpine calceolarias. The first section is chiefly botanical, although in the gardens of the south-west several of the species form really decorative shrubs. The second is remarkable for its large, richly coloured flowers, the result of constant crossing and selection by cultivators. The plants are treated as annuals and raised from seeds every year. The bedding section is used with Geraniums, Lobelias, &c., being raised from cuttings set in soil in a cold frame in the autumn, where they remain till planting-out time in the following year. The Alpine sorts, namely *C. plantaginea* and *C. polyrrhiza*, are perennials which thrive in a sheltered place in the rock garden. [W. W.]

Calcite.—Calcium carbonate (carbonate of lime, often popularly styled 'lime') commonly



Crystal of Calcite, showing starting of cleavage cracks and a fragment produced by cleavage

occurs in the form of Calcite (see art. ARAGONITE). Calcite or Calc-spar ($CaCO_3$) is colourless or white, though occasionally stained by iron compounds. It can be easily scratched with a knife. The crystals belong to the trigonal division of the hexagonal system, and have three remarkably good sets of cleavage-planes; consequently, when fractured, they break into little brick-like forms, with angles of 105° and 75°. Like aragonite, calcite effervesces freely when placed in cold hydrochloric acid or even vinegar, giving off carbon dioxide as it dissolves.

Calcite forms the bulk of the rocks called limestone, whether these result from the accumulation of sea-shells or have been deposited from material held by seas or running water in solution (see art. CALCAREOUS TUFA). It is often seen as white veins in limestone. It is attacked by rainwater, or by streams containing carbon dioxide, and goes into solution as a bicarbonate. Hence it is one of the greatest sources of the lime that is brought in solution into soils. In many gravels it forms a cement round the pebbles on which it has been deposited when the water dried away. [G. A. J. C.]

Calcium is a metallic element, and it belongs to a group of elements called the alkaline earths. The other metals forming this group are barium, strontium, and magnesium. The element does not exist in nature in the free state, but always in combination with other elements. Some of the best-known compounds of calcium are: the oxide of calcium (quicklime), carbonate of calcium (chalk), sulphate of calcium (gypsum), sulphide of calcium (gas lime). From their extensive occurrence in nature, uses, and from their basic and other properties, the compounds of calcium are of great commercial and agricultural value.

The element in an uncombined state is a light-yellow-coloured metal, of about the same hardness as gold, but rapidly tarnishes in moist air. [R. A. B.]

Calcium Compounds in Soil.—The most important of these are the carbonate, phosphate, sulphate, silicate, and humate; in addition, the bicarbonate and nitrate are found in drainage water.

CALCIUM CARBONATE ($CaCO_3$) occurs pure in large transparent crystals as *calcite*, also called *calc-spar* or *Iceland spar*, and *aragonite*. Large masses of small calcite crystals occur as limestone and as marble, which is white when pure but coloured when certain impurities are present. Chalk is practically pure calcium carbonate, and is formed of shells and other remains of organisms deposited in water. Some of the limestones, *e.g.* the Carboniferous and Devonian, are very hard, and are used for road metal; others yield excellent freestones (*i.e.* they can readily be cut into blocks), *e.g.* the oolitic deposits at Portland, Bath, Somerset, and elsewhere. The magnesian limestones of Nottinghamshire, Derbyshire, and Yorkshire, so called because they contain a large proportion of magnesium carbonate, yield valuable building stones. Chalk does not generally furnish building stones, though sandy beds in Devonshire (at Beer) and Bedfordshire (at Totternhoe) are quarried for this purpose. Soft white chalk is used for whiting; chalk is also used, along with river mud, in making Portland cement. Both limestone and chalk are exten-

sively used for making lime. Carboniferous limestone and the upper chalk yield a very pure form well suited for agricultural purposes. The lower chalk and limestones containing some clayey material yield an impure lime containing also alumina; this is more valuable for building and for hydraulic purposes than the purer lime, and therefore of higher price, but it is less useful agriculturally. Lime obtained from magnesian limestones (dolomites) is avoided by farmers. Calcium carbonate also occurs disseminated throughout the soil as the result of the weathering of calcium silicate and of the decomposition of plants.

Calcium carbonate is not very soluble in pure water, but dissolves fairly readily in water containing carbonic acid, and it is then converted into the soluble bicarbonate. It is therefore continually being washed out of the soil into the drainage water; the average loss per acre per annum throughout England and Wales has been estimated at 500 lb.,[1] and at Rothamsted on the arable land at 800 to 1000 lb.[2] The rate of loss is influenced by the manuring, being increased by the use of ammonium sulphate, and decreased by dung (see art. Manures, Effect of on Soil) and by the crop; it is much less on pasture than on arable land. Illustrations of the solubility of calcium carbonate are common in limestone districts; caverns and underground passages have been produced by the constant action of carbonic acid and water on the limestone rock. The bicarbonate produced is not stable, but readily changes back into the carbonate when the excess of carbonic acid is removed. Water coming from chalk or limestone is hard because of the dissolved bicarbonate, but on boiling it deposits calcium carbonate and loses some of its hardness; the calcium carbonate constitutes the 'fur' which rapidly coats kettles and boilers in chalk districts. In some cases the calcium carbonate is deposited as the water issues from the rock, as in the well-known stalactites, stalagmites, and petrifying springs of limestone and chalk formations. Calcium carbonate may in the same way deposit in the soil from the soil water, encrusting the particles and cementing them together. Thus it increases the coherence of sandy soils, and may in extreme cases form a hard-pan.

When calcium carbonate is heated it is converted into lime, and carbonic acid is given off. The change is readily reversible; lime quickly absorbs carbonic acid from the air, forming calcium carbonate again. The three bodies lime, calcium carbonate, and calcium bicarbonate are related thus:—

Lime contains no carbonic acid.
Calcium carbonate contains one dose of carbonic acid.
Calcium bicarbonate contains two doses of carbonic acid.

If exposed to air, lime and calcium bicarbonate tend to change into calcium carbonate, but in the soil the tendency is to change into the bicarbonate, because of the large amount of carbonic acid present. Thus a dressing of lime is virtually the same thing as a dressing of chalk, excepting that lime is more finely divided than chalk and so distributes better in the soil, and lime has also certain caustic properties from which chalk is free.

Calcium bicarbonate has a remarkable effect on clay, flocculating the fine particles so that they now behave somewhat like coarser ones; the typical clay properties, plasticity, stickiness, and impermeability partly disappear. Clay soils are therefore much improved by calcium bicarbonate; they can be worked more readily, water drains away and air gets at the roots of the plant much better as a result of the action. 'Chalking' or 'liming' clay soils is effective because the chalk or lime quickly changes into the bicarbonate.

Calcium carbonate acts in the soil as a base, *i.e.* it neutralizes the acid constantly being formed in the soil by the action of micro-organisms on organic matter, or by the decomposition of certain manures, like ammonium sulphate. This property is of great agricultural importance, since all ordinary schemes of farming require neutral conditions in the soil. The bacterial flora is also considerably modified when acid is present; the desirable changes—the breaking down of organic matter and the formation of nitrates—being largely suppressed, and a number of other changes take place, resulting in an accumulation of black acid bodies of peaty nature, quite unsuited to plant growth. Certain disease organisms, *e.g.* the Plasmodiophora, causing finger-and-toe or anbury in turnips, also thrive in acid soils. These acid or 'sour' conditions when they arise must be remedied by dressings of lime or chalk.

Calcium carbonate brings about other chemical changes in the soil. It appears to liberate potash from insoluble silicates, and so increases the amount of available plant food. On the other hand, it depresses the availability of phosphates.

Experiments made by Loew in the United States and in Japan show that calcium carbonate (or lime) is a potent agent for overcoming the ill effects of excessive amounts of magnesia in the soil.

In consequence of the washing out of calcium carbonate already mentioned, some soils occur which are quite free from it. In this respect it is unique, no other soil constituent can be completely removed from the soil or is ever entirely lacking, and hence a great division of soils is possible into those that contain calcium carbonate and those that do not. Each of these divisions has its characteristic flora — bacterial as well as plant—for some plants will not tolerate calcium carbonate or can do without it, whilst others will not tolerate the acid conditions which arise in its absence (see art. Soils). Instances of the former are the well-known calcifuges, broom, spurry, &c., and trees like the conifers; the latter include many of the ordinary farm crops. Soils free from calcium carbonate are not as a rule productive, and are often uncultivated; in Great Britain instances are found among the commons, moors, heaths, and

[1] T. M. Reade, Chemical Denudation in Relation to Geological Time.
[2] Hall and Miller, Proc. Roy. Soc., 1905, 77, 7.

barren sandy tracts. Other examples are furnished by the 'Heideboden' of North Germany, and the long-leaf pine and short-leaf pine regions of Mississippi and Alabama. In some parts of the United States the contrast between the regions where calcium carbonate is absent and those where it occurs is so marked that the saying has arisen, 'A lime country is a rich country'.

Excess of calcium carbonate is, however, as bad as deficiency, and the poverty of the chalk soils is proverbial. This arises in part from the lightness and porousness of the soil, and partly from an unhealthy condition to which plants are liable (see art. FERTILITY). The bacterial processes also appear to be modified, since chalky soils are often abnormally rich in nitrogen.

As a rule fertile soils contain not less than ·5 per cent of calcium carbonate. Some good sands and clays fall below this limit; in these cases liming is found to be profitable. If more than 10 per cent is present, the soil may be too light and porous to yield heavy crops. The absence of lime is shown quite clearly by the character of the vegetation, but chemical determination is necessary to ascertain if a soil is near the limit. Calcium carbonate is decomposed by acids with evolution of carbonic acid gas, and the amount of gas evolved when acid is poured on to a known weight of soil affords a measure of the amount of carbonate present; other carbonates also behave in the same way, but normal cultivated soils contain only calcium carbonate. Various methods are in use for measuring the amount of carbonic acid evolved. When the soil contains more than 1 per cent of calcium carbonate, Scheibler's calcimeter gives sufficiently accurate results. If less than ·5 per cent is present it is necessary to use a more sensitive method. Such methods have been described by Hall and Russell (Trans. Chem. Soc., 1902, 81, 81) and by Amos (Jour. of Agric. Science, 1905, i, 322). The exact estimation of minute quantities of carbonates in soils is very difficult, because the acid also attacks some of the organic matter present and forms carbonic acid.

CALCIUM PHOSPHATE ($Ca_3(PO_4)_2$) is an invariable constituent of soils. It rarely occurs pure, but is associated either with the fluoride, as apatite, or with the carbonate, as phosphorite, raw phosphate, coprolites, &c. Apatite is occasionally found as good colourless crystals, but is somewhat widely distributed as minute crystals in granite, basalt, and the soils derived therefrom. Phosphorite or raw phosphate occurs in enormous masses in certain parts of the world, and as nodules in the Bala beds, the Lower Greensand, the base of the chalk, and the base of the crag in Suffolk; it is almost invariably associated with chalk or limestone. The large beds at Estremadura, in Spain, were described in 1845 by Daubeny and Widdington.[1] In the same year Professor Henslow directed attention to the deposits of coprolites occurring below the chalk in Surrey, Cambridge, and the eastern counties. The name 'coprolite' (literally 'fossilized dung') arose from the erroneous idea that the nodules were in all cases the fossilized dung of extinct animals; it now seems more probable that many of them arose from the shells or bodies of organisms, or that they have been formed by the accumulation of phosphatic matter in and around some centre, such as decaying silica sponges. The English phosphate deposits were for some years used in making superphosphates, but they were soon exhausted, and their place was taken by French and Belgian deposits. The most prolific mines are those of South Carolina, which supply two well-known grades: one from the islands, known as land phosphate, contains some iron and aluminium phosphates, the other dredged from the beds of rivers and called river phosphate; the latter is purer, and is preferred by English manufacturers. Valuable deposits also occur in Florida ('hard rock' and 'pebble' phosphates) and Tennessee. Of recent years the deposits of Algeria and Tunis, which are nearly free from iron and aluminium, and contain only calcium carbonate as impurity, have become very important; supplies also come from the Pacific islands. Calcium phosphate may originally have been formed by the oxidation of phosphides in the igneous rocks, but the present deposits are of animal origin. Its formation is still going on in some of the Pacific islands. The guano deposited by the birds oxidizes under the influence of air and moisture, leaving a phosphatic residue which reacts with the calcium carbonate in the rock below to form calcium phosphates. Some of the beds in other parts of the world may have been formed in this way. The formation of the nodules has been already dealt with.

Calcium phosphate is only slightly soluble in water, but, like calcium carbonate, it dissolves more readily if carbonic acid is present. It is, therefore, useful as manure; Daubeny (see above) made successful field trials with the Estremadura phosphates, and Paine[1] showed that the phosphatic nodules in and below the chalk had considerable value. Dehérain[2] demonstrated the value of the French phosphates on the soils of Brittany and the Landes when lime was absent, and Söderbaum[3] obtained good results on the Swedish moorland soils. However, they are of little use on soils containing calcium carbonate, and as they vary considerably in action it is altogether better that they should be converted into superphosphate and not used in the raw state as manure.

CALCIUM SULPHATE ($CaSO_4 \cdot 2\,H_2O$), gypsum or selenite, occurs as crystals in many clays, and also as semicrystalline nodules and veins in the Triassic marls of Cumberland, Westmorland, Durham, Derbyshire, Nottinghamshire, Staffordshire, and Somersetshire, and in the Purbeck beds of Sussex and Dorset. Fine granular kinds are known as alabaster. It is somewhat soluble in water, and imparts to clay waters some of their permanent hardness, *i.e.* the hardness that is not destroyed by boiling. It favours the growth of leguminous plants, and was at one time used as manure, but special dressings are

[1] Journ. Royal Agric. Soc., 1845, 7, 333.

[1] Journ. Roy. Agric. Soc., 1848, 9, 56.
[2] Chimie Agricole, 2nd ed., p. 847.
[3] Jahresbericht Agrik. Chemie, 1905, 8, 133.

not now necessary, since it is contained in superphosphate. Its manurial value is often supposed to be due to a reaction with some of the zeolitic constituents of the soil, whereby potash is liberated; the potash, and not the gypsum, being regarded as the direct cause of the increased growth. Dymond, however, has pointed out that the amount of sulphate in the soil may be insufficient for the full development of crops rich in protein. In these cases gypsum has the directly beneficial effect of supplying sulphur.[1] Gypsum has a favourable effect on nitrification. It has been extensively used in the United States to overcome the injurious effect of the 'black alkali' occurring in certain soils. See ALKALI SOILS.

CALCIUM HUMATE is described under HUMUS, and CALCIUM SILICATE under SOIL. [E. J. R.]

Calcium Cyanamide, the term applied by agricultural chemists to a nitrogenous manure which was first produced in 1903. It is known commercially as lime nitrogen and as nitrogen lime, and its properties and agricultural uses will be found under the former term. See LIME NITROGEN.

Calculi, Stones, Concretions.—Stones or calculi are found within the bodies of all the

Rounded Calculus

different species of domesticated animals, and are of varying composition and density, from the soft and loosely constructed concretions primarily composed of the dust taken in food, to the hardest bodies, comparable with flints. Those spoken of as concretions or bowel stones are always met with in the large intestine, although the foreign body or nucleus has probably made its way through the small gut first. The surface may be convoluted like the brain, or perfectly smooth, and the stones vary in size from a few grains to many pounds in weight. Millers' horses and others partaking largely of ground foods are specially subject to concretions. A nucleus is usually found, and may consist of any fragment of insoluble matter, such as a broken nail or piece of plaster, of wood, metal, or of the beards of certain cereals, around which deposits of phosphatic matter accumulate, mixed with hardened mucus. Their presence may never be suspected, and no trouble caused during a long life, provided that they remain pouched and quiescent in some sacculation of the bowel; but their displacement, from any unusual movements of the gut, may result in colic, impaction, and death. Purgative medicines frequently bring about their expulsion.

Bowel stones are roughly but conveniently divided into phosphatic, oat-hair, and mixed or mulberry (from the resemblance of the latter to berries). Analysed, they are found to consist of phosphates of ammonia, magnesia, and lime, silica, and alkaline salts, with some 30 per cent of animal matter, made up of intestinal mucous and digestive secretions. Stones in the bladder are of somewhat different composition, and of more serious import. That they are due to precipitation of the salts held loosely in solution in normal urine is beyond question, but the reason why some horses eliminate great quantities of lime salts is not known, and does not appear to have any direct relation to the food or water, or we should find a larger proportion of such cases in limestone districts. Analysis shows carbonate of lime as forming from 60 to 85 per cent; carbonate of magnesia, 3 to 8; oxalate of lime, 2 to 17; phosphate of lime, 4 to 6; organic matter, 5 to 6 per cent.

Ammonio-magnesian phosphates accumulate in the urethral canal of the bull and ram, and in the vermiform process, as the result of excessive feeding on mangolds, and sterility has in some instances been traced to this source. See BLADDER, DISEASES OF. [H. L.]

Calendars.—There is this difference between agriculture, gardening, and rural occupations generally, and all other industries, viz. that the events peculiar to them are recurrent. The same cycle of operations, varying only in detail, is completed with the passage of every successive year. And thus it is that a calendar which summarizes the out-of-door work proper to each month of the year may serve as a useful guide and remembrancer to the farmer. Especially at busy seasons, or when the attention is engrossed in some special work, a calendar performs a useful service in recalling to the mind duties which might otherwise be overlooked. 'At the beginning of every month,' remarks Arthur Young, 'a good farmer, whether he has or has not a calendar, is obliged to reflect on the work he has to perform in that month; he ought to foresee the whole at once, or it is impossible he should make a proper provision for its performance.'

The work usually performed in any given month will be found recorded in the alphabetical position of the month in the present work. Thus under 'April' four articles appear, dealing respectively with farm work in Southern and in Northern Britain, and with gardening operations in the same areas. It should be understood that Southern Britain refers especially to the district round London, and Northern Britain to the district round Glasgow. The times stated

[1] Journ. Agric. Science, 1905, 1, 217: Dymond, Hughes, and Jupe.

for the performance of the various agricultural and horticultural operations are only relative, and will vary naturally with the soil, climate, exposure, latitude, and elevation of any particular area. Within certain limits, however, they may be calculated to meet the two latter variations by reckoning the operations four days later for every 70 miles north of London or Glasgow, as the case may be, and for every 600 ft. of elevation above sea level. But while an empirical rule of this kind, based upon general observation, may be found to satisfy the majority of cases, it will not be found applicable to every locality. In particular, the factor of climate varies so much in Britain as to outweigh all other considerations. Individual judgment and experience must therefore be called upon to effect such modifications as particular circumstances demand. See also arts. WEATHER IN RELATION TO AGRICULTURE, EXPOSURE, ELEVATION, &c. [J. B.]

Calendula.—The Pot Marigold (*C. officinalis*) is one of the most useful of summer annuals. There are many forms of it, most of which come true from seeds. These may be sown in the open border in spring, and thinned to 6 in. apart when the seedlings are well up. Both the double and single-flowered forms are popular, Prince of Orange and Le Proust being two of the best. The species is a native of South Europe, but is naturalized, in gardens at any rate, in this country. The flowers formerly were held in repute as a domestic medicine, being used in the form of an emulsion for poultices. An extract of the flowers is sometimes used for colouring butter and cheese. [W. W.]

Calf Pens.—At the ordinary farm, special provision is seldom made for the accommodation of calves. Generally some spare shed not far apart from the cowhouse (if this can be got) is taken advantage of for the purpose. It is quite common at the smaller dairy farms in the West of Scotland, where wholly-covered-in pighouses are prevalent, to see the older calves being housed therein during the early part of the season, before cheesemaking has been started and young pigs have been laid in to consume the resulting whey. And these places, where of modern construction, being both airy and comfortable and well lighted to boot, answer well as calf pens. There is no reason, however, other than carelessness or inattention, why proper accommodation is not more generally forthcoming for the very young members of our cattle stocks. The young things are sure to thrive best in a house that is well aired without being draughty, that can be kept fairly warm inside without becoming offensive in its atmosphere, and in which there is plenty of light. In a place of this kind, provided that, irrespective of litter, it is dry underneath, the animals are certain to thrive if well attended to otherwise. And the requirements just specified are surely attainable at most farm homesteads without much difficulty. It is not wise, of course, to keep too many calves together. It is better management to grade them according to size, with so many in a compartment to themselves. At this rate the calfhouse or shed set apart for the calves should be divided into as many separate places as circumstances warrant. These are best when fitted up as so many loose boxes, grouped somewhat on the principles laid down for the arrangement of cattle sheds. A good plan is to have a shed fitted up as a miniature byre, in which the young calves are tied by the neck, in a manner similar to their elders, as they are introduced to the world. Each has a trough and heck or fodder rack to itself, and no more room than allows it lying space. Here they remain fastened up until the oldest among them are drafted to a shed or loose box to make room for later comers. For six or seven weeks at least each calf is apprenticed to confinement within walls in this way. See also BUILDINGS, FARM. [R. H.]

Calf-rearing.—The natural method of rearing a calf is to let it run with its dam, and feed according to its appetite and its mother's inclination. In this way the best calves are made, and for that reason the calves of high-class pedigree herds are reared by their dams, although not, as a rule, allowed free access to them. The calves of slow-growing, poor-milking breeds, such as the Galloway and West Highland, which graze on exposed and inferior pastures, are also reared on the udder, and the same system prevails in many commercial herds, in which, to save labour and ensure good stores, the cows raise one, two, or three calves each. In the north of Scotland, where this system is well understood, those calves are believed to be more economical than if raised by the pail; but on good land, where grazing and milk are dear, and skimmed or separated milk abundant, pail-fed calves are in the majority, and probably in the circumstances the cheapest. For the sake of clearness and brevity the various methods are classified as follows, it being understood that when calves are reared artificially, whole milk is always given for a longer or shorter time:—

NATURAL METHODS.. { (*a*) in pedigree herds.
(*b*) in commercial herds.

ARTIFICIAL METHODS { (*a*) with skimmed or separated milk.
(*b*) with skimmed milk and a cream substitute.
(*c*) with a milk equivalent.

NATURAL.— PEDIGREE HERDS.—In pedigree herds from which expensive stock are sold, each cow rears her own calf only, and the system varies as between one herd and another only in the minutest details. In the case of the heavier beef breeds the cow is generally tied up and the calf penned or tied close by, and allowed access to the mother at regular intervals.

A leading breeder of Shorthorn cattle in Aberdeenshire, whose bull calves are brought out in a condition never excelled, and sold at prices second to none, thus describes his system: 'My general plan is to let my calves go in lots of from six to eight each in loose boxes or pens. They are suckled when very young four times daily, and when older (three months or thereby) three times. In summer they accompany their dams on the pasture. I like to wean them when about eight months old. When the calves are two or three months old they get a

little linseed cake and hay, and afterwards some cut yellow turnips. On the grass they get no extra food for the first two months, but after that they get a little composite linseed cake in the field. The heifer calves seldom get any cake on the grass. This system is subject to variation in special cases.'

A well-known breeder of Aberdeen-Angus cattle in England allows the calves to be suckled by the cow four times daily till a fortnight old, then three times until the cows go to grass, when they suck at will. So long as the calves are housed they are tied up, and the owner considers that they thrive much better on three feeds daily than if allowed the full use of the cow. The bull calves in this herd are given 1½ to 2 lb. of linseed cake or compound feeding cake in July when about six months old, and they remain with the cow and receive cake till at least ten months old. Cows with bull calves graze on young grass or 'seeds', and cows with heifer calves on the poorer pasture. It is noticeable that in both of those typical instances the calves are not allowed to run with the dam for some months after birth. In pedigree herds the cost of rearing the calf is unimportant if the stock are fashionably bred and in great demand, but is necessarily higher than in commercial herds, and will seldom be less than £10 or £12 at weaning.

Estimated Cost of Rearing a Pedigree Bull Calf to Eight or Nine Months Old (North of Scotland)

		£	s.	d.
Winter—Seven months:				
Cow	8 tons turnips or other roots at 10*s.* per ton	4	0	0
	1½ to 2 tons straw, or straw and hay, at 40*s.* per ton ...	4	0	0
	Cake, at and after calving ...	0	10	0
Summer—Five months:				
Cow and Calf	2 ac. grass at 20*s.* per acre ...	2	0	0
	1½ lb. cake per day to calf for four months	0	12	6
	Attendance on cow and calf	1	0	0
		12	2	6

Natural.—Commercial Herds.—In commercial herds a much greater variety of method may be found. On upland and hill farms of cheap grass land the cows, of whatever breed except dairy cattle, generally rear one calf only. The calves are dropped in spring, and weaned when the grass fails and they have learned to eat hay and turnips. Such calves are expensive, and only profitable when of first-class quality and when their dams can be cheaply wintered. Blue-grey calves, the progeny of a white or roan Shorthorn bull and Galloway cows, are reared in the south of Scotland and the north of England on this plan, and if dropped at the right time are worth from £7, 10*s.* to £9 when weaned. Mr. Joseph Vickers, of Elm Park, Tow Law, in County Durham, has raised calves from a herd of forty Galloway cows by this method for many years. The cows are pure-bred, and cost as heifers in calf from £18 to £24. A white Shorthorn bull is put to the cows early in June, and the calves arrive from March to May Day. The cows and calves run on the rough land along with blackfaced sheep till the end of October, when the calves are weaned and sold at from £7, 10*s.* to £9, 5*s.* The cows graze on the same land till after Christmas, when they are sheltered at night and given a little hay night and morning.

In the same district two calves are sometimes put to a cow, but the calves are worth less at weaning, and the cow must get better than moorland pasture.

Estimated Cost of Rearing a Blue-grey Calf (North of England)

	£	s.	d.
Hay for five months	2	0	0
Grazing	2	0	0
Share of bull's keep and service ...	1	0	0
Depreciation on cow stock and deaths	1	0	0
	6	0	0

The value of the cows' manure may be set against attendance and litter.

In the mixed farming and cattle-feeding districts of Scotland and the north of England, indeed in any area outside of the dairying counties, two or three calves are often reared by one cow. Typical examples of this method are to be found anywhere in the east of Scotland, and they only differ in the breeds or crosses which are kept. In Fifeshire, one well-known feeder rears all his own stock from twenty cross cows, which, mated with an Aberdeen-Angus bull, raise their own calves and two others. The cows calve in March or April, and a purchased calf is in readiness to share the cow with its own offspring. The two calves are weaned in the end of August and a third calf put on. This calf is housed, as a rule, and the cow is brought in from pasture several times a day to feed it. As the cow at that time is rather run down, she gets extra feeding. The third calf is weaned in November, and the cow is wintered chiefly on turnips and straw. On the smaller farms of Aberdeenshire and Morayshire, especially in the upland districts, four or five cows rear all the stock required on the same system, the extra calves being obtained from crofters and cottars in the neighbourhood. The essentials for success are cows of fair milking capacity, a supply of well-bred calves, and personal supervision. If the cow refuses her milk to the strange calf while at grass, the difficulty can be overcome by chaining the stranger to her own calf, so that though she can prevent both from sucking, she cannot discriminate against either. The chain must have a swivel or swivels, and should be from 2 to 3 ft. long.

Estimated Cost of Rearing a Calf by Above Method

	£	s.	d.
Winter—Seven months' keep:			
Turnips and straw	8	10	0
4 lb. cake and corn for three autumn months	1	0	0
Summer—Five months:			
2 ac. grass at 20*s.*	2	0	0
Share of bull's keep and service ...	1	0	0
Depreciation and deaths	1	0	0
	13	10	0

As three calves are reared, each calf has cost one-third of £13, 10*s.*, or £4, 10*s.*; and if originally worth £2, 10*s.*, must be saleable for £7 at six months old.

Artificial Methods.—

Treatment of New-born Calf.—When calves are reared by artificial methods it is customary to remove them from their dams as soon as they are born, but some breeders allow them to remain with their mothers for a few days. If a box is available, there are some advantages in leaving the cow and calf together at first. Nothing seems to bring the calf more quickly to its feet than the licking it receives from its mother, and it has the full advantage of the medicinal value of the biestings (colostrum) at the proper temperature. On the other hand, when the calf is taken away it is alleged that the cow does not settle so quickly or milk so well, and the calf is longer in learning to drink from a pail. The choice is chiefly to be determined by convenience, and if a box is available, the writer believes in leaving the cow and calf together for a day or two. When the calf is removed, the best place for it is a well-lighted, well-ventilated box or crib at least 5 ft. by 5 ft., with a concrete floor sufficiently sloped to carry off all moisture. The best bedding material for calves is peat moss litter, which keeps them cleaner and has greater absorptive capacity than straw. If cribs or boxes are not available, the youngsters will do well tied up until they are a month or six weeks old. By this time they will be able to nibble at cake and hay, and the danger of their learning to suck each other will be nearly over, so they can be put together in lots of four or more in pens or courts until they go out to grass. Winter-born calves do well on grass, but calves dropped in late spring or summer will thrive best in the house. When the calf has been well rubbed down, if not with its mother, it may be given its first drink by allowing it to suck two fingers of the attendant, who gently lowers its head until its mouth is in the biestings. In a couple of days the calf will require no teaching. Several inventions for calf-feeding in the shape of pails with rubber-tube attachments for sucking have been tried, but they are more difficult to clean than a pail, and clean utensils are of supreme importance in calf-rearing. The calf receives its mother's milk for a week, and the same, or at all events whole milk, for another week, and then its diet is altered, as will now be described.

Skimmed or Separated Milk.—In a few districts, chiefly in Ireland, calves are fed on separated or skimmed milk, and practically nothing else after the second week. This method is only mentioned to be condemned. Such a food is unbalanced, is almost entirely wanting in necessary fat, and, as the experiments of the Irish Department of Agriculture have proved, is invariably uneconomical.

Skimmed or Separated Milk and a Cream Substitute.—This is the common diet for pail-fed calves, and in considering it the reader should keep in mind that separated milk and skimmed milk are assumed to be the same, though skimmed milk is richer in fat than separated milk, while the latter has the advantage over the former in being fresh and warm when fed to the calves. The following are some of the foods used or recommended in substitution of the fat of milk or to eke out a supply of whole milk: hay tea, linseed tea, carrageen moss or seaweed, ground oats, Indian corn, wheat, barley, beans and peas, wheat flour, sugar, cod-liver oil, and ground linseed, in addition to numerous proprietary articles. Linseed meal, oatmeal, Indian meal, and cod-liver oil were used in the experiments undertaken by the Irish Department of Agriculture. From the results of several years' trials it appears that separated milk was a ration invariably the least economical except whole milk. Cod-liver oil has been successfully used, and at or below 5*s.* per gallon is a profitable cream substitute. Other experiments with the same substance have shown equally good results, and no injurious taints have been detected in the flesh by butchers, while calves fed on cod-liver oil have wintered and grazed as well as, or better than others. The advantages of cod-liver oil are its cleanliness, convenience, and readiness for use. The mixture of meals has given the best financial returns in two years of the three, and if it can be prepared for 10*s.* 6*d.* per cwt. is recommended by the Irish Department of Agriculture as more economical than cod-liver oil at 5*s.* per gallon. The mixture consisted in 1902 and 1903 of 2 parts by weight of Indian meal, 2 parts of oatmeal, and 1 part of pure ground linseed.

W. T. Lawrence, County Council Farm, Penrith, who has great experience of calf-rearing by many methods, also recommends cod-liver oil, but considers a mixture of ground linseed and Indian meal cheaper if the oil costs 5*s.* per gallon. This mixture, with which Mr. Lawrence has been very successful, consists of 1 part of Indian meal to 7 parts of whole linseed ground with the meal. When the mixture is scalded and stirred with boiling water, a small teacupful of flour per quart of meal per gallon of water is added. The flour is to correct the laxative tendency of the linseed. One pint of this porridge, which need be prepared only once a week, is used with 5 or 6 gal. of separated milk. The writer has also found, after many trials, that ground linseed is the most satisfactory basis of any cream substitute. Assuming that cod-liver oil is cheap, the calf should get half a tablespoonful three times a day well mixed with its milk during its second and third weeks, and a full tablespoonful of the oil three times a day after the fourth week, when the whole milk has been discontinued. If a meal mixture such as the one described is used, a Shorthorn or cross calf will require about the following quantities, but success depends on regularity of feeding, gradual alteration of quantities, and close personal supervision. Until six weeks old the calf should be fed three times a day.

Kinds and Quantities of Food per Day

First week—Its mother's milk, 3 to 5 qt.
Second week—5 to 6 qt. of new milk.
Third week—3 qt. of new milk and 4 qt. of separated milk with ½ pt. of meal porridge, gradually decreasing the new milk until by the fifth or

Sixth week the calf is receiving only separated milk at the rate of 8 to 9 qt. per day with 1 pt. of porridge.
Seventh week.—By this time the calf can eat linseed cake and hay, which should be supplied to it in increasing quantities as its appetite indicates. Two meals of separated milk of about 1 gal. each will now be sufficient along with the porridge, and this feeding may continue to the
Tenth week, when the porridge may be omitted. The cake should increase to ½ lb. or ¾ lb. per day, and sliced swedes should be given in winter, or tares, green grass, or clover in summer. The separated milk is continued at the rate of 2 gal. per day until the
Twenty-fourth week, when it gradually ceases, and the calf may continue its growth on the swedes, hay, cake, and corn.

Estimated Cost of Rearing a Pail-fed Calf to Six Months Old

For twenty-four weeks—

	£	s.	d.
116 qt. new milk at 1½d. per qt. ...	0	14	6
359 gal. separated milk at 1d. per gal.	1	9	2
Linseed meal	0	1	6
25 st. hay at 4½d. per st.	0	11	0
54 lb. linseed cake at £8 per ton ...	0	2	10
28 lb. crushed oats at 9d. per st. ...	0	1	6
9 st. swedes at ¾d. per stone	0	0	7
Labour and attendance, 6d. per week	0	12	0
	3	13	1

The value of the manure may be set against the litter, but not against the attendance, which is an important item. If the calf originally cost £2, 10s., it must sell at £6, 10s. at six months old to pay its way.

Milk Equivalents.—It is possible to rear calves without milk after the second or third week, but such calves have never the size, fleshiness, or general well-nourished appearance of milk-fed calves. They are pot-bellied and hidebound as a rule. Several firms of feeding-stuffs merchants manufacture and sell meals specially compounded for calf-rearing without milk, and fair success has attended the use of some of them.

Mr. Lawrence, in the Board of Agriculture Journal of March, 1905, describes three home-made meals which he has used with good results when little or no milk was available.

No. 1.—To be used with a small quantity of separated milk—

8 parts of oatmeal by weight.
1 part of ground linseed.

Scald 2¼ lb. overnight with 5 pt. of boiling water, boil for ten minutes next morning, and add 5 pt. of separated milk with ¼ oz. of salt and 2 oz. of sugar.

No. 2.—When no separated milk is available—

2 parts linseed-cake meal.
2 parts oatmeal.
1 part ground linseed.

Mix with 5 qt. of boiling water overnight, and boil for ten minutes next morning; serve with salt and sugar as with No. 1.

No. 3.—When no separated milk is available—

14 parts linseed-cake meal.
5 parts ground linseed.
2 parts wheat flour.
2 parts locust-bean meal.

This requires no boiling, but 3 lb. should be mixed with 5 qt. of boiling water and a sprinkle of salt.

Each of these is a day's allowance for a calf, and should be given warm at three meals to one under three months old, and at two meals above that age. When No. 2 or No. 3 is used it should be introduced, and the new milk reduced, very gradually, thus:—

First week, mother's milk only.
Second and third weeks—3 pt. of new milk and 1 pt. of the gruel at each of three meals.
Fourth and fifth weeks—2 pt. new milk and 2 pt. gruel.
Sixth and seventh weeks—1 pt. new milk and 3 pt. gruel.
Eighth week—2 qt. of gruel and no new milk.
Hay should be given at the fifth week.

Calf Ailments.—White scour is a common and often fatal disease in young calves. The microbes which are the cause gain entrance by the freshly broken navel string. To prevent attack the navel should be rubbed with carbolic oil or dilute lysol as soon as the calf is born. Mild digestive troubles are often put right by a dose of bicarbonate of soda, or a spoonful of lime water in the milk. Calves which appear out of order and thriftless will often improve if given a raw egg and a spoonful of treacle in the milk for a day or two. [R. B. G.]

Calf's Snout. See Antirrhinum.

Caliche, a Spanish word applied to lumpy impurities in bricks. In South America it is the name for the bed, at times 6 ft. thick, in which commercial sodium nitrate (Chile saltpetre) occurs. Caliche when it is worked contains 20 per cent and upwards of sodium nitrate; some deposits contain 50 per cent. The Chile saltpetre is obtained from this by purification, so that from a 'saltpetre earth' containing 4 to 10 per cent of nitrogen, which is the substance required by the agriculturist, a product is obtained with 14 to 16 per cent. Pure sodium nitrate contains 16·47 per cent of nitrogen. The impurities in caliche are mostly rock-salt, sodium sulphate, and potassium iodide and iodate. Caliche occurs, under a gravelly bed which contains gypsum, in the rainless district of Atacama. (Mayer, Agrikulturchemie, Bd. ii, Abth. 2, 1902, p. 146; Fuchs and Delaunay, Gîtes minéraux, tome i, 1893, p. 421.)

[G. A. J. C.]

Calkins.—Calkins are 'downward prolongations of the limbs' of a horseshoe, made while

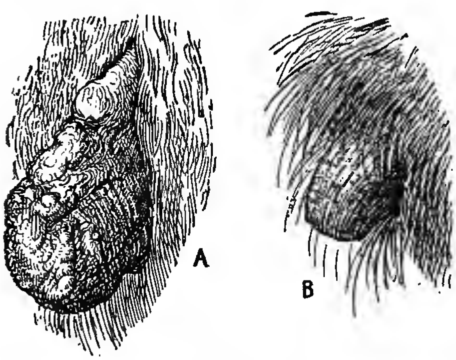
Too high A preferable form
Calkins

the iron is hot, and intended to afford greater grip of the ground in the case of heavy draught horses. They are also employed to relieve strain of the back tendons, and are frequently prescribed in connection with various forms of lameness. Pieces of steel are occasionally welded into the heel to form calkins where

specially hard wear is anticipated. Similar prolongations of the shoe at the toe or sides are made in cities, where stone setts make the roads unusually difficult for draught horses to secure a foothold, and are more commonly spoken of as toe-grips. [H. L.]

Calliphora vomitoria, Linn. (the Bluebottle Fly), is a serious pest during the summer and autumn, when it will fly-blow almost every description of animal food, and its fecundity is very extraordinary. The eggs are elliptical, pellucid-white, and generally laid in masses; the maggots are white and fat, tapering to the head, and blunt at the tail, which is surrounded with eleven minute tubercles enclosing two spiracles; the viscera shine through the skin and give them a clouded tint, with a dark line down the back; the puparium is of a deep rusty colour, cylindrical, and elongate-ovate. The fly expands nearly one inch; is black and bristly; the face and base of antennæ of a bright rusty colour; thorax greyish, with four indistinct stripes; abdomen bright steel-blue, reflecting grey, with three black bands; scales at the base dusky; wings transparent, with two oblique nervures, the upper cell open at the tip. An allied species, *C. erythrocephala*, has similar economy. It can be told by the head having black hairs beneath instead of tawny red ones. [J. C.] [F. V. T.]

Callosities. — Callosities are chiefly interesting as supposed vestigial remains, but



Callosities

A, A large chestnut from a cart mare. B, Ergot from same animal.

their origin is admittedly obscure. They take the form of horny excrescences on the inside of the forearm and back of the fetlock joints, and are popularly known as chestnuts and ergots. They are as insensitive as the horn of the foot, and are cut away by the blacksmith from time to time as they become unsightly. The term 'callosity' is sometimes applied to the callus or callous condition attained after injuries to bone. [H. L.]

Calluna, the Ling or Heath of British commons and hillsides. *C. vulgaris* is the only species. It has been improved under cultivation, the varieties *alba*, *rosea*, *rubra* being forms that are grown either in beds on the lawn or in groups in borders. They are excellent as a covering for slopes, as when once established they require practically no attention. They are easily propagated either by means of seeds or cuttings. See also HEATH. [W. W.]

Callus.—A permanently thickened or hardened structure is spoken of as a callus (or incorrectly callous), and in veterinary surgery implies more than induration and increase; it supposes accommodation, and freedom from pain in an injured part, whereby it is restored to usefulness and unlikely to be a further cause of distress, as in the case of a union in a fractured bone; the various processes having been completed and repair effected in such a manner that only a callus, or no more than normally sensitive condition, remains. Spavins, ringbones, splints, and other ossific deposits become callous, and the term is employed by horsemen in regard to thickened tendons or indurated skin in the same sense. [H. L.]

Calorimeter is an instrument for measuring quantities of heat. It is used for determining quantities of heat evolved in chemical actions, and for measuring the amount of heat produced by animals. The instrument in the latter case is sometimes called a respiration calorimeter. There are several forms of respiration calorimeters. In the first place, all of them must be large enough to hold the animal, and in the second, when the experiment is carried on for some length of time, there must be some means of admitting a current of air for ventilation, and for measuring the amount of water vapour carried out on the ventilating current. Either water or air may be used for measuring the heat produced, but for full particulars of the different kinds of respiration calorimeters the reader must consult a text-book on physics. For measuring the heat evolved in chemical actions and for determining the heat of combustion of substances, vessels made of platinum or silver, and containing water or air, are used. [R. A. B.]

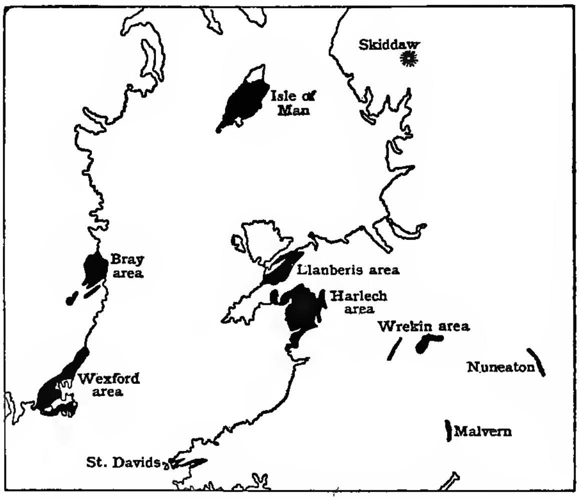
Caltha, the genus of plants (order Ranunculaceæ) which contains the Marsh Marigold (*C. palustris*), so common in our marshes and ditches, and which is effective when planted in wet ground or on the edge of a pond or stream, where its dark-green, kidney-shaped leaves and rich yellow buttercup-like flowers, 2 in. across, are charming in spring. There are varieties with white and double flowers. In the north the flowers are gathered and sold as May flowers. The plant is reputed to be acrid and poisonous. It is perennial, and has a stout creeping rootstock. [W. W.]

Calving.—The critical period of calving should be anticipated by drying off cows at least a month or six weeks before the expected date of parturition, and the udder should be periodically examined to ascertain that no curdles remain to act as foci for garget and other inflammatory troubles at the birth of the calf. Heifers pregnant for the first time should not be herded with other young stock that may ride or otherwise excite them and provoke abortion. A comfortable loose box should be pro-

vided for the expectant mother, the floor and walls of which should be disinfected as a precaution against the disease germs now known to give rise to maladies in connection with both cow and calf at the period of birth. Short clean straw is to be preferred to other forms of bedding, as not liable to hang up and become twisted round the weakly limbs of the newborn, or, like peat moss and sawdust, gain access to the eyes, nostrils, and mouth. Overfeeding with rich foods is undesirable, and constipation must be guarded against. Calving difficulties will be discussed under the heading of PARTURITION. [H. L.]

Calycanthus, a genus of shrubs related to Magnolia, with single leaves, and solitary, axillary, rosette-like flowers of a lurid red or brown colour, and very fragrant. The best known is *C. florida*, the Carolina Allspice, a compact bush, 6 ft. to 8 ft. high, with brown-purple flowers produced in early summer. There is a variety of it with variegated leaves. *C. occidentalis* is a larger-growing species, with ovate-cordate leaves and bright-crimson flowers. Both species require a sheltered situation. They are happiest in the south-west in a soil in which rhododendrons flourish. [W. W.]

Camargue Horses. — A breed of horses found in the Camargue district of the Rhone delta. There is no fixed type of the Camargue horse, but, generally speaking, it forms an inferior breed, standing about 13 hands high. The head is coarse, the neck and shoulders light; the backbone is prominent and the outline angular. The legs are light and somewhat weak, while the feet are large and flat. The colour is mostly light-grey. Though defective in conformation, the Camargue horses are hardy and active. They are mostly used as light draught horses, but they are also adapted for farm work.



Sketch-map showing distribution of Cambrian strata in England, Wales, and Ireland, the areas being marked in black

Cambrian System. — This system of rocks includes at its base the beds containing the oldest well-marked fauna of the globe, namely, that characterized by the trilobite Olenellus and its allies. Earlier faunas, of which we have only traces at the present time, are classed as pre-Cambrian, and as belonging to the Archæan era.

The name Cambrian was derived from the ancient name of Wales by Sedgwick, who worked among these difficult strata about 1832. Though his System was at first more extended, it has now been restricted by general consent to the following British series:—

Upper Cambrian	4. Tremadoc Stage.
	3. Lingula Flags Stage.
Middle ,,	2. Menevian Series.
Lower ,,	1. Llanberis and Harlech Series.

The rocks of the Longmynd on the Welsh border were formerly regarded as equivalent to the more western Harlech Beds; but they have been relegated since 1885 to the pre-Cambrian systems, through the discovery of the Olenellus fauna in higher beds in Shropshire.

The HARLECH SERIES may also be proved some day to be pre-Cambrian, since these ancient slates and sandstones have as yet yielded no definite fauna. They rise in huge fort-like masses above the Barmouth estuary and the Harlech coast, and the famous Bwlch Drws Ardudwy, a semicircular notch, affords a passage through them from the east. The country here is scarcely cultivated, though woods gather in the picturesque valleys towards the sea. The valuable slates of Llanberis and Bethesda similarly form mountain-land east of Carnarvon, and contain remains of Lower Cambrian trilobites. The MENEVIAN SERIES occurs above Lower Cambrian strata in the St. David's area, and above the Harlech Series near Barmouth. The LINGULA FLAGS, a series of slates and fissile sandstones, with abundant shells of the brachiopod now known as Lingulella, form a stretch of moor and upland, with mountain farms, north of Dolgelly, and occupy the lower slopes of Cader Idris. They spread north to Ffestiniog, and are overlain by the TREMADOC slates. The oldest rocks of the English Lake District, the SKIDDAW SLATES, are probably in large part Cambrian.

In contrast with the siliceous and argillaceous character of the deposits formed in the Cambrian sea in southern Britain, the Cambrian of Scotland, known only in the western Highlands, includes the fossiliferous dolomitic limestone of Durness. This runs as a well-marked land, often thickened by repetitions due to faulting, from the north of Sutherland at least as far as Skye. The sandstones under it are now converted into quartzite, and rest unconformably on the brown-red pre-Cambrian Torridon Sandstone. The mountains formed by the latter

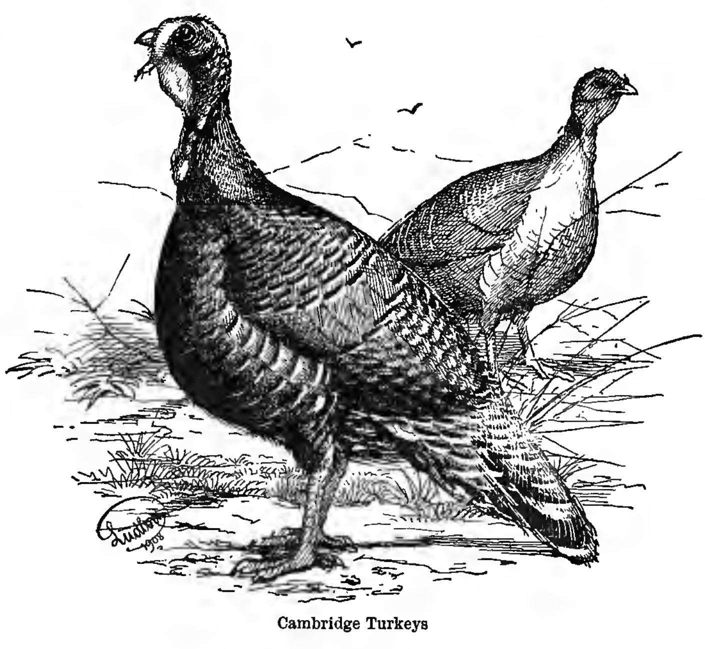
rock are often capped by the white Lower Cambrian quartzite, which resembles snow when viewed in bright sunshine from a distance. The lands of the Scottish Cambrian area, despite the ameliorating presence of the limestone, are essentially a part of the wilder Highland country.

In Ireland a large body of slates and quartzites, extending from Bray to near Rathdrum in Co. Wicklow, and forming also a less hilly region round Wexford town, is regarded as being of Cambrian age. The agricultural character of these areas depends, however, almost entirely on the drift gravels and boulder-clays with which the lower ground has been freely covered during glacial times. Where an arable soil is directly derived from the rock, as in some parts of Co. Wexford, it always requires liming. The quartzites in Co. Wicklow form bold projecting masses in the midst of more gently sloping and heather-clad moorland.

Dr. Daubeny's conclusions as to the absence of phosphoric anhydride from Cambrian strata (Journ. Chem. Soc., vol. vii) were set aside when these beds were adequately described. In some of the specimens analysed by Dr. Hicks and Mr. Hudleston, the proportion of phosphoric anhydride was as much as 1·50 per cent. The earlier types of brachiopods, such as Lingulella, Discina, &c., which abound in many Cambrian strata, belong to the division in which the shell consists of alternate layers of horny matter and phosphate of lime; and the trilobites, a group of ancient crustaceans, also utilized the latter material, with carbonate of lime, in the construction of their carapaces. Hence there is no ground for supposing that strata of high antiquity may prove specially poor in phosphatic supplies. (See H. Hicks, 'Occurrence of Phosphates in Cambrian Rocks', Quart. Journ. Geol. Soc. Lond., vol. xxxi, 1875, p. 368.) [G. A. J. C.]

Cambrian Soils.—The soils derived from the Cambrian rocks, as represented in the British Isles, are of subordinate importance in the agriculture of the country. As has been shown, the system is confined in these islands to remote mountainous districts, where, owing to the steep, elevated, and rugged condition of the ground, tillage is scarcely practicable. The land is mostly left in a state of nature, but turned to good account as a pasturage for hardy races of sheep and cattle, wherever the character of the vegetation is good enough for that purpose.

The soils of the Cambrian slopes, when not reinforced by drift, are usually very thin and poor; but in the lower ground deeper soils accumulate, and these, if well treated, will produce profitable crops. They are typically cold, stiff, and unresponsive, except to the best farming. A few of the Cambrian rocks produce soils of better physical condition than the type of soil just described; among these are the Tremadoc slates near Portmadoc and St. David's. The grey Menevian shales, also of St. David's, on the Pembrokeshire coast, produce a soil of comparative fertility (M'Connell, Agricultural Geology, p. 168). Chemically the soils are poor in some of the most important fertilizing ingredients. The cause of this well-marked poverty may be explained by the continuous leaching action undergone by the rocks from which they have been derived, through the successive ages that have elapsed since Cambrian times. Lime and potash are, in fact,



Cambridge Turkeys

generally present in quantities inadequate for the production of remunerative crops. The addition of these ingredients to the soil is therefore desirable, and drainage, too, is frequently necessary. [T. H.]

Cambridge Turkey.—In the middle of last century the turkey most commonly found in Cambridgeshire was grey in plumage, as it was considered hardier than those of other colours, such as the brown and black-and-white, which were also met with in that section of eastern England. That greys could easily be obtained from black-hued birds (see Black Turkey) is undoubted, but it is of interest to note that one of the best races found in the United Kingdom, so far as quality of flesh is concerned, is that bred in southern Ireland, and it is largely grey in colour. It is possible that both own the same origin, though upon

this point no evidence is obtainable. But for the fact that the Irish turkey is small in size, it would command a better position on our markets. To the old grey turkey the present Cambridge Bronze owes much, as that was the basis on which it was formed. First it was crossed with a copper or brown variety, and afterwards with the American Bronze. The result has been to increase the size, and to give a greater amount of vigour to the constitution, retaining the well-covered sternum, the soft thick breast meat and fine texture of flesh, for which the breed was noted. Comparatively useless for exhibition purposes, by reason of its dull, homely plumage, when dead it stands clearly first of any we have seen either in Europe or America.

In shape the Cambridge turkey is shorter-bodied than the American Bronze, but is very deep, without great prominence of keel or breast-blade, giving it a cobby appearance, which is added to by the absence of pouch or bag in front. Otherwise it resembles the entire species, save that it has not the length of neck and legs seen in some breeds. It is light in bone, and has a roomy carcass, to which a large quantity of flesh can be added when fed off. The ground colour of the plumage is of a dull bronze, with practically no sheen, and many of the feathers have tips of grey and white, the tail and wings having bars of the last-named colours. The beak and toe nails are flesh-coloured, and the legs and feet dark grey, varying somewhat with age. As a rule, fully grown cocks reach 24 lb. and hens 16 lb., but yearling cocks run well over 20 lb. when fatted at Christmas. Much depends upon the treatment during the growing and fattening stages (see TURKEY BREEDING AND REARING). Where the object is primarily to produce turkeys for market, no finer breed has yet been found, and it equals the Black Norfolk for texture of the flesh. With a growing tendency in demand for medium-sized birds, it should become more popular. The hens are good layers, and make first-rate sitters and mothers. They are also very tame, and will bear handling. [E. B.]

Cambridgeshire Pigs.—A very considerable change has taken place during the last quarter of a century in the form and character of the pigs common to this county. The old type of pig is still found on a few isolated out-of-the-world Fen farms, where stores of heavily salted and fat sides of bacon are cured in the winter to furnish food for the farmer's family and men during the summer. The oldfashioned, curly-coated, blue-and-white, coarse boned and fleshed pigs furnish large carcasses of pork suitable for the purpose, but very few indeed of this class of hog now appear on the public markets, where they would realize a lower price and meet a lessened demand. There is a distinctive character amongst these lop-eared, strong-haired, and heavy-boned pigs, which can be grown into massive beasts if time and meal are not considered, but they do not appear to supply a want save in the district and for the purpose named. The sows are prolific and good sucklers, whilst the little pigs are hardy and of quick growth when young. Still, it is doubtful if this style of pig would be profitable in any district except where quantities of inferior corn and small or diseased potatoes, which have little, if any, market value, are to be found. The greatest change in the character of the pigs kept in the Fen districts appears to have been due to the introduction of Large and Middle White boars, which have improved the quality and the early maturity of the local pigs very considerably, whilst the robustness, hardihood, and free-milking qualities have been retained. Very large numbers of these crossbred or improved pigs are now bred in the county and sold into Derbyshire, Staffordshire, and other dairying counties, where they are fattened on the dairy offals and then sold for consumption in the so-called Black Country. In the south-eastern portion of the county quite another distinct type of pig was common. This was a black-and-white pig, the white portion being confined to a band round the body, something after the style of a breed of cattle cultivated in the States. These sheeted pigs, as they were locally termed, grew to a considerable size, and furnished a carcass of good pork for bacon-curing purposes. They were somewhat high on leg and flattened in ribs, the snout and back long, the ears pendulous. The sows were prolific and good milkers; the young pigs were hardy and grew rapidly. The pigs required, or rather were allowed, age before being put up to fatten, and were somewhat slow in manufacturing flesh. To remedy this last failing many farmers crossed their sheeted sows with the Small Black boars which were so fashionable some forty years ago. The result was not a success, as the resultant pig was not of the kind now in demand; besides, the old local breed, which must have had some qualities both good and suitable to the district, was wellnigh lost. One occasionally sees a few specimens of this particoloured pig at the local markets, proving that it was of an impressive character. Some pig-breeders in Essex use a Large White boar and then reserve for sows all the sheeted female produce. [S. S.]

Camel.—Camels are ruminating, ungulate (hoofed) animals, which differ in so many structural characters from other members of this group, comprising the oxen, antelopes, sheep, giraffes, and deer, that, in conjunction with the llamas (see ALPACA), they are commonly placed in a special section known as the Tylopoda. This name alludes to the structure of the feet, which, instead of being encased in hard and horny hoofs, are soft and padded below, and terminate in flattened nails. In the young, also, there are six incisor teeth in the upper jaw, although usually only a single pair persists in the adult. The canine tooth is distinct in both jaws, and in the lower jaw does not form a continuous series with the incisors, and the first of the cheek teeth (first premolar) is either missing, as in the llamas, or is isolated from the rest and simulates a second canine, as in the camels. The stomach also is unlike that of other ruminants, especially in the fact that the paunch possesses a number of receptacles or cells suitable for the storage of water, and capable of

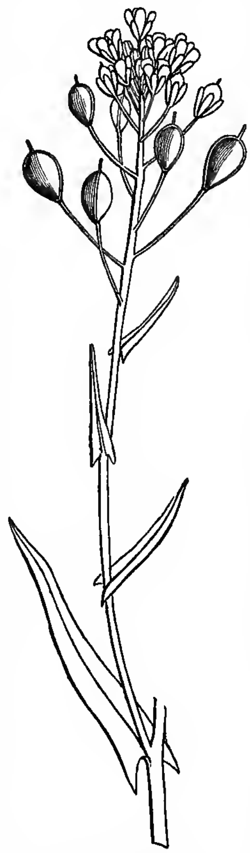
taining it on account of their contractile orifices. Camels differ from llamas externally in having one or two humps on the back, short rounded ears, and longish tails, the terminal hairs of which nearly reach the hocks. The toes, moreover, are united to a greater extent by the pad on their under surfaces. The whole organization of camels is eminently adapted for life in their natural habitat, namely, dry sandy countries. Their broad, padded, plantigrade feet enable them to pass swiftly over loose, shifting sand, where horses can make little headway. They thrive on the coarse vegetation the deserts produce; are able to live a considerable time without a fresh supply of water on account of the fluid stored up in their water cells; and when food itself is scarce, can sustain privation by absorbing the fatty tissue of which the dorsal humps are composed. Pairing takes place in the spring, and the period of gestation is thirteen months. Only one young one is born at a birth.

There are two well-marked species of camel, the best known, commonly called the Dromedary (*Camelus dromedarius*), being an inhabitant originally of Arabia and Syria. The distinctive feature of this species is the presence of a single dorsal hump. The name Dromedary, although generally applied to all one-humped camels, belongs by right only to a particular lightly built variety, remarkable for its speed, and used for racing and rapid transport, which differs considerably from the more heavily built baggage camels. Other varieties are recognized by the Arabs, but the above-mentioned are the most important. In the desert tracts of north Africa and south-western Asia immense herds of these camels are kept by the nomadic tribes, with whom they take the place of the horses, sheep, and cattle of European nations, supplying meat, milk, and wool, and acting as beasts of burden and transport. For the latter purpose they have been introduced with varying success into different countries. They are extensively used in the north-western provinces of India; and large numbers were sent for military service into German South-west Africa during the native war of 1906. Their introduction into Australia has proved a great success; and feral descendants of tame camels are still found in Spain and some of the southern States of North America.

The second species of camel, known as the Bactrian Camel (*Camelus bactrianus*), is, as its name suggests, an inhabitant of Central Asia, being widely distributed over the desert regions of Turkestan and Southern Siberia. It is a more heavily built, shorter-legged animal than the Dromedary, and in accordance with its more northern range and the intensity of the winter cold to which it is subjected, grows a thicker and longer coat, the hair being produced in greatest profusion upon the throat, the upper portion of the fore legs, and the summit of the head. The winter coat is moulted in great masses in the spring, leaving the skin nearly naked before the new coat appears. But the most noticeable character distinguishing this species from the Dromedary is the presence of two humps instead of one on the back. Bactrian camels are found in a wild state in parts of the Desert of Gobi; but it is a disputed point whether these animals are the last representatives of the original wild species which was formerly in all probability widely distributed in Central Asia, or whether they are the feral descendants of tame specimens. The latter is probably the correct view, since the district they inhabit was formerly occupied by man, and was deserted on account of a tremendous and destructive sandstorm that desolated the country some two centuries ago, and killed off, it is believed, every human being that lived there.

Unlike the Dromedary, the Bactrian Camel, which is used as a beast of burden and for supplying milk and wool, has not become differentiated into various breeds, and has not been exported on an extensive scale to other countries. Hybrids between the two species have been produced in captivity, and these are alleged to be fertile *inter se*.

[R. I. P.]



Camelina or Gold of Pleasu
(*Camelina sativa*)

Camelina or **Gold of Pleasure** (*Camelina sativa*) is an annual cruciferous plant found in flax and corn fields, apparently wild. It is very common in the central parts of Europe, but is supposed not to be really a native of this island. Its roots are fibrous; its stems erect, about 2 ft. high; its leaves smooth, narrow, bright-green, arrow-shaped, stem-clasping; the flowers small and yellow, with four small equal sepals, four undivided petals, and six stamens, four long and two short. The fruit is an obovate, tumid pod (silicula), which separates when ripe into two convex valves. In each of the two chambers of the pouch there are several oblong compressed wingless seeds. Each seed contains an embryo composed of two flat seed-leaves and a radicle bent so as to lie along the surface of the cotyledons.

Like many other cruciferous species, such as Rape, the seeds of this plant abound in oil, for the sake of which it is cultivated. The oil is sweet, and eatable when fresh, but is apt to become rancid; it burns well, and freezes with difficulty. On the Continent, Camelina is a

common crop; it is sown usually in the spring, but may be deferred till June in countries having a warm, dry autumn. Three months bring it to maturity in such districts. It is sown broadcast at the rate of about 4 lb. an acre, and is harvested when the seed-pods begin to turn yellow. If too ripe, it is apt to shell. It is said to prefer good wheat land; but is found to pay on the Continent on inferior sandy soils. In England the crop is averaged at from 3 to 4 qr. an acre. [J. L.] [A. N. M'A.]

Camellia, a stout shrub or small tree, native of Japan, closely related to the tea plant now known as *Camellia Thea.* It was cultivated and improved in Japanese gardens long before its introduction to Europe, where until recently it was known only as a greenhouse shrub. Fifty years ago the popularity of the Camellia was far greater than it is now; but the discovery that in the warmer parts of the British Islands it is as hardy as the Cherry Laurel has led to a revival in its favour, and it is planted as a hardy evergreen which always looks bright, and when in flower in early summer is particularly attractive. It is happiest in positions sheltered from north and east winds and shaded from early morning sun, and it prefers a peaty soil with plenty of moisture at the root. In the garden of Lord Falmouth's seat near Truro there are upwards of 1000 Camellia bushes, many of them 10 ft. high and 30 ft. round. The variety *Donckelaari,* which has large, semi-double, deep-red flowers, is one of the best for outdoor cultivation. [W. W.]

Camembert Cheese.—Perhaps the most popular of French—nay, of Continental—cheeses, Camembert comes near to being the smallest of them all, as it almost certainly is the daintiest and most attractive from a dietetic point of view. The French regard it as an indispensable relish, and so do many other than French people. Indeed it is a relish rather than a food, just the one thing that a man will take when dinner has really come to an end, and when further appetite cannot easily be tempted.

It is a flat and circular cheese, contained in little boxes of thin wood or of some other material, about 4 in. in diameter and an inch or so deep. Interested persons have tried to envelop it in an air of mystery, with the object of restricting the make of it and keeping up prices. All this is nonsense, for it is not a difficult cheese to make, though it may easily be an impossible cheese to ripen—in *new dairies.* It is made from milk whose cream has not been taken out of it, and as it ripens in about a month it is really a soft cheese, though this softness is only developed in the ripening. The ripening cannot be perfectly accomplished in the absence of the mould whose action produces the special flavour of Camembert cheese. With the aid of the special mould, fair Camemberts have been, and are being, produced in England. It is not an economical cheese as a food, because only the soft interior of it is edible. Indeed it must be regarded as a luxury rather than a food. [J. P. S.]

Cammock. See Rest Harrow.

Camomile.—A well-known domestic tonic and febrifuge known as Camomile Tea is made from the flower-heads of *Anthemis nobilis,* a perennial herb wild and cultivated in this and other countries, being grown as a field crop at Mitcham. The double-flowered form is preferred. The flowers are also used in fomentations. The plant has branching stems, the leaves divided into linear segments, and the flowers are daisy-like, the ray flowers being absent in some forms. See Chamomile. [W. W.]

Campanula.—This is the technical name for a genus of herbaceous dicotyledons belonging to the nat. ord. Campanulaceæ, or true bluebells. The best-known species is the Harebell or Bluebell of Scotland (*Campanula rotundifolia*). The Rampion (*Campanula Rapunculus*) is cultivated for its edible root. [A. N. M'A.]

Rampion (*Campanula Rapunculus*)

About 230 species are known, and they are distributed in all temperate and most tropical countries, nine of them being natives of Britain. Some of the taller kinds are excellent border plants, while the smaller-growing, more or less trailing species are most serviceable for furnishing rockeries. Chimney Flower (*C. pyramidalis*) is cultivated as a biennial; it has a stout rootstock on which forms a large rosette of linear-oblong leaves, the flower-stem rising from the centre to a height of 3 ft. to 6 ft., the flowers being arranged in a tall pyramid expanding in the autumn. There are blue and white varieties. The Canterbury Bell (*C. medium*) is one of our best border plants. The seeds are sown in March in a frame, the seedlings transplanted to a bed in the open in June, being lifted to a bed in September, to be placed in the borders, where they will flower in the following June. *C. persicifolia* is a beautiful perennial, with peach-like leaves and elegant stems 2 ft. to 3 ft. high, clothed with large, bell-shaped, blue or white single or double flowers. The best of the smaller species are *C. carpatica, C. fragilis, C. garganica, C. pulla,* and *C. pusilla.* They are all summer-

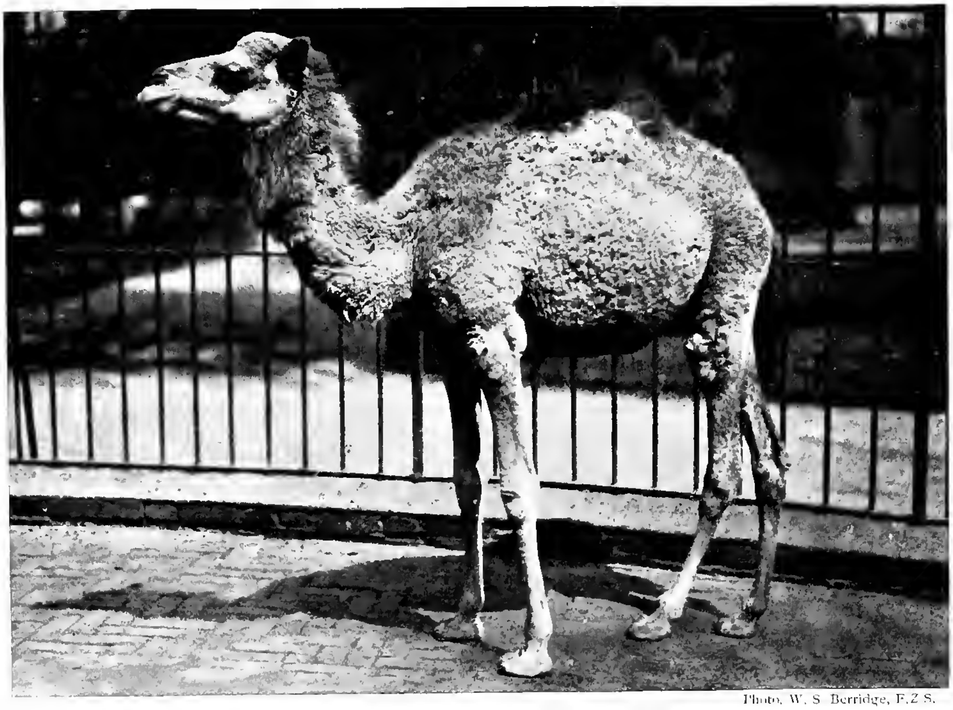


Photo. W. S. Berridge, F.Z.S.

YOUNG DROMEDARY

Photo. W. S. Berridge, F.Z.S.

BACTRIAN CAMEL

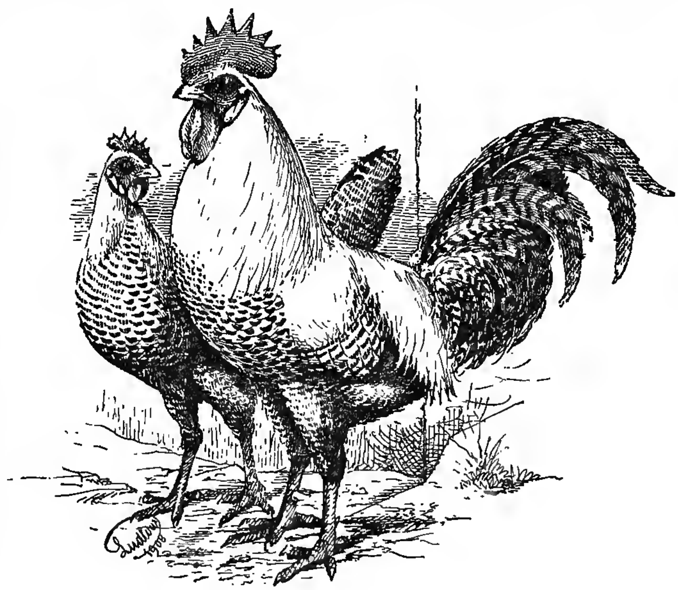
flowering, and they ripen seeds freely. The Rampion (*C. Rapunculus*), a native of Great Britain, is a biennial with running white succulent roots, which are eaten as a salad. [W. W.]

Campanulaceæ.—This is the name for the nat. ord. of dicotyledonous plants which contains the Bluebell, the true Bluebell of Scotland. This order shares with heathers and heaths two peculiarities—the bell of heather persists in a withered state on the fruit, so does the bell of bluebell; the stamens of heathers are not adherent to the petals, neither are the stamens of bluebells. The distinctive characters are: (1) petals grown together, forming a regular bell; (2) a chambered ovary not in the inside, but on the outside of the flower; (3) the five stamens attached to the top of the ovary. The plants are herbs with simple narrow leaves and milky juice. The important weeds of the order are: Bluebell (*Campanula rotundifolia*), a blue-flowered perennial on dry sands; Sheep's-bit (*Jasione montana*), a blue-flowered annual or biennial on dry sands, with its flowers collected in dense heads, like those of a composite. [A. N. M'A.]

Camphor is the name of an oxygen derivative of a hydrocarbon. It is volatile, and possesses a very characteristic odour. There are several well-known camphors, and as regards their chemical composition they may be said to fall into four groups or homologues: (1) Peppermint Camphor (Menthol); (2) Borneo Camphor (Borneol); (3) Laurel Camphor; (4) Thyme Camphor (Thymol). Camphors are mostly crystalline substances, insoluble in water, but soluble in alcohol. They are found in the organs of certain plants, from which they can be separated by distilling in steam.

The common camphor is obtained from the Camphor Laurel, a tree inhabiting Formosa, Japan, Central China, and other tropical climates. In Japan the camphor tree is allowed to attain the age of 100 years before it is cut for the purpose of extracting the camphor. Camphor is used in medicine for its stimulant and antiseptic properties, and it is largely consumed by the natives of India. [R. A. B.]

Campine Fowl.—Reference is made in another section (see BRAEKEL FOWL) to the fact that the Braekel and Campine own the same ancestry, and are natives of Belgium, where, and in Holland also, fowls of a similar type are widely distributed. From all that can be discovered these birds have been known for several centuries, but upon that point definite information is lacking. A greater amount of attention has been paid to purity of race in Belgium than in Holland, for the Flemish people are remarkably skilful in all matters relating to breeding of animals and birds. For some time it was thought that our Pencilled Hamburghs (see HAMBURGHS) were descended from the Campine, as they are similar in all respects save comb. Later observations, however, have led to a modification of this opinion, as it is not improbable that they came from the Friesland fowl, which has a rose comb, and is, consequently, nearly allied to the Hamburgh. But it may be accepted that centuries ago the Braekel, Campine, and Friesland fowls had the same progenitors and were identical, such differences as have manifested themselves being the result of artificial selection and



Campine Fowls

varying conditions. The last-named explains the small size of the Campine, which for a long time has been bred on the sandy lands of North Belgium between the city of Malines and the Dutch border, where activity of habit is essential as food is scarce, and where the tendency in all animals is towards small size of body. Campines have been introduced into Britain and secured a fair amount of favour, but chiefly as exhibition stock. But many of these are Braekels, not Campines.

In shape the Campine is long in body, but small and narrow, fairly round in breast, very well developed behind, and the legs are of medium length. It is alert and active, quick in movement, fairly good in carriage, the head held well up. There are two colours, namely, the gold and the silver. The former have a ground colour of golden-yellow, the latter of silvery-white, upon which in each variety there are markings or pencillings across the greater part of the body feathers of black, not consisting of solid but of pencilled bars. In some

cases these are irregular, but in the better specimens evenness of marking adds greatly to the appearance. The comb is single, evenly not deeply serrated, standing upright in the male, and falling over on one side in the female; it is of a good size, but not excessively so, and, with the wattles, is bright-red. The ear lobes are bluish-white, and the legs and feet, which are clean and free from feathers, dark slate-blue. As already indicated, the Campine is small in body, a desirable quality in a breed kept primarily for egg production. It ranges from 4½ to 5 lb. in the cocks, and 3½ to 4 lb. in the females. Under suitable conditions they are hardy, but from their active nature are not well disposed to confinement, preferring full liberty where they are able to forage for food all day. From what has been stated it will be evident that the Campine is not of much value for table purposes. At one time their eggs were like those of the Hamburgh, small in size and pure-white in shell, but by careful selection the size has been increased very considerably, and is now equal to market requirements. Upon the lighter lands where space is plentiful this breed can be recommended. [E. B.]

Campion.—Campion is a name applied to various plants (weeds) of the chickweed order (Caryophyllaceæ). All the campions that belong to the genus Lychnis are marked by the five sepals of the calyx grown together, and by the five distinct styles that crown the ovary. (1) Corn Campion or Corn-cockle (*Lychnis Githago*), with poisonous seeds, is described under the name Corn-cockle. (2) White Campion (*Lychnis vespertina*) is an erect, hairy, perennial weed of corn and damp pasture, 1 or 2 ft. high. The hairs are soft, but as we approach the flowers they become viscid so as to entrap insects crawling up to the flowers. The flowers are loosely arranged; the oldest flower is in the centre, and a pair of younger ones spring out opposite to one another from its stalk. The petals are white, five in number, and cleft. One Campion plant is female, and devotes itself entirely to seed-making; another is male and devotes itself to pollen-making. (3) Red Campion (*Lychnis diurna*) agrees closely with White Campion. The red or pink petals are the chief distinguishing feature. Its calyx is shorter than the corolla, and this distinguishes from the red-flowered Rose Campion or Corn-cockle. Bladder Campion is not a Lychnis, but a white-flowered Silene which has its number of styles reduced from five to three. The botanical name is *Silene inflata*. This species often occurs in sandy pastures by the sea. The skin is waxy and quite bald. The sepals of the calyx are grown together, and form a puffed-up bladdery body in which a fine network of violet veins is readily noticed. To prevent the spread of these Campion weeds seeding should be prevented. [A. N. M'A.]

Campoplex paniscus, an ichneumon fly, the maggot of which lives in the caterpillars of *Plutella maculipennis*. *C. paniscus* is black; wings transparent; thighs reddish; shanks whitish, hinder with a ring near the base, and the tip brown; feet whitish, tipped with brown, hinder brown, excepting the base; length nearly ¼ in.; oviduct curved, $\frac{1}{12}$ in. long. [J. C.] [F. V. T.]

Canada, Agriculture of.—The Dominion of Canada is composed of nine provinces, having a total land area of approximately 1,400,000 sq. miles, together with an area of 2,100,000 sq. miles unorganized and only partially explored. It occupies most of the continent north of the United States from the Atlantic to the Pacific, besides islands. Its most southern point in Ontario is at 42° north latitude. Apart from the Yukon district, the present northern limit of occupation is found at about 55° north latitude in Alberta. The occupied land amounts to only about 100,000 sq. miles. It will be seen that only two-fifths of the entire Dominion has as yet been included in the organized provinces, and only about 3 per cent of the entire area is as yet occupied. While it is a matter of conjecture as to how much of the remaining 97 per cent is available for occupation, it is safe to say that within a few years the occupied area will be increased many times over. The following table gives statistics as to area and population taken from the latest census of Canada (1901). The provinces are given in order, beginning at the east:—

Provinces.	Land Area (acres).	Occupied Area (acres).	Total Population.	Rural Population.
Nova Scotia	13,483,671	5,080,901	459,574	330,191
Prince Edward Island	1,397,991	1,194,508	103,259	88,304
New Brunswick ...	17,863,266	4,443,400	331,120	253,835
Quebec	218,723,687	14,444,175	1,648,898	992,667
Ontario	141,125,330	21,349,524	2,182,947	1,247,190
Manitoba	41,169,098	8,843,347	254,947	184,714
North-west Territories	187,932,617	6,569,064	158,940	120,767
British Columbia ...	236,922,177	1,497,382	177,272	87,825
Unorganized	—	—	52,709	43,608

During the session of the parliament of the Dominion of Canada, 1907-8, provision was made for the extension of the boundaries of the provinces of Manitoba, Ontario, and Quebec. When the new arrangement has been completed the following will be the areas of the three provinces as enlarged, viz.:—

Manitoba	242,427	sq. miles.
Ontario	366,908	,,
Quebec	696,717	,,

The following are the areas of the two new provinces formed in 1905:—

Alberta	253,540	sq. miles.
Saskatchewan	250,650	,,

Subsequent to the taking of the census in 1901 the three districts comprised in the North-west Territories, viz. Alberta, Saskatchewan, and Assiniboia, were organized into two provinces, now called Saskatchewan and Alberta. The former lies west of and next to Manitoba, and Alberta lies west of it and along the eastern boundary of British Columbia. It will be seen that Prince Edward Island is the smallest province and British Columbia is the largest; also that Ontario has the largest occupied area, the largest total population, and the largest farming population.

The cities and towns of Canada have made remarkable progress of recent years, thereby increasing the home demand for food supplies. Notwithstanding this, the quantities of farm products available for export have increased at a rapid rate. The table in next column, giving the agricultural exports of domestic origin, will, therefore, illustrate the steady increase in the agricultural output, and will show the extraordinary expansion of the past fifteen years. The Dominion of Canada was organized under this name in 1867.

Owing to a change in the time of convening the Canadian Parliament, it was found necessary to change the ending of the fiscal year from July 1st to April 1st. For the nine months ending April 1st, 1907, the exports were as follows:—Animals and products, $52,785,520; field products, $35,856,616; total farm products exported, $88,642,136.

EXPORTS OF FARM PRODUCTS FROM CANADA (of domestic origin).

Year ending July 1st.	Animals and their products.	Field products.	Total farm products.
1868	$6,470,332	$12,871,055	$19,341,387
1873	13,307,044	14,995,340	28,302,384
1878	12,793,256	18,008,754	30,802,010
1883	19,196,820	22,818,519	42,015,339
1888	22,751,096	15,436,360	38,187,456
1893	30,253,416	22,049,490	52,302,906
1898	42,771,573	33,063,285	75,834,858
1903	67,419,044	44,624,321	112,043,365
1904	61,664,159	37,138,875	98,803,034
1905	60,956,875	29,994,150	90,951,025
1906	63,991,623	54,062,337	115,053,960

(These sums may easily be converted into sterling money by taking $5 as equal to £1.)

The increase in animal products during recent years is owing largely to the expansion of Canadian export trade to Great Britain in bacon, cheese, and butter; the increase in field products is due to the great expansion of wheat farming in Manitoba, Saskatchewan, and Alberta.

The following statement of farm values by provinces is from the census of 1901:—

Provinces.	Value of Farm Property.	Value of Field Products.	Value of Fruit and Vegetable Products.	Value of Animal Products.
Nova Scotia	$70,694,395	$9,764,493	$1,407,369	$5,846,290
Prince Edward Island	30,434,089	4,764,674	139,004	2,648,623
New Brunswick ...	50,506,018	8,110,918	394,337	4,510,657
Quebec..	430,154,421	46,993,237	2,564,801	35,456,171
Ontario	1,001,323,296	109,182,192	7,809,084	83,684,111
Manitoba	149,617,965	16,815,192	163,958	7,221,883
North-west Territories	76,331,742	7,294,283	80,553	5,508,013
British Columbia ...	32,465,512	3,479,682	435,794	2,740,079
Totals	$1,841,527,438	$203,405,443	$12,994,900	$147,615,827

At the time of taking the census, just one-third of the farmed lands were situated in Ontario, but the farm property of that province was valued at over one-half of the entire farm property of Canada. The most striking and suggestive statement in the above table, however, is that nearly 60 per cent of the animal products of Canada are credited to Ontario. The values of field crops of Manitoba and the North-west Territories have materially increased since 1901, as will be seen later on in this article. One point should be kept in mind in connection with such a table as the above, viz. that a considerable portion of the field products is reckoned in a second time under animal products. Making allowance for this, it might be a safe estimate to state that the total products of the farms of Canada in 1901 exceeded in value $300,000,000. The total value in the year 1906 may, on a fair estimate, be set down at $400,000,000, of which approximately one-half came from Ontario. The rapid extension of railroads is opening up new areas of cultivable land, and the population is rapidly growing, both by natural increase and by immigration. As a consequence, the output of agriculture is making more than normal increase. For comparison it might here be stated that in the census year the capital invested in manufactures was $446,916,487; and the value of forest products was $51,082,689.

We shall now briefly refer to the agriculture of the Dominion by provinces.

NOVA SCOTIA.—Nova Scotia has an area of about 20,000 square miles. The country is in places quite hilly, in fact mountainous. The climate is influenced by that fact, and also by the fact that the province is surrounded by the sea. A little over one-third is occupied by farm lands. Lumbering, fishing, and mining are important industries, and divide with agriculture the attention of the people. The river valleys are fine fruit districts. Apples, plums, and cherries are produced in great abundance and of extra fine quality. Pears and peaches also are produced in limited quantities. There are over 32,000 ac. in orchards. The tides enrich the lands along the coast and permit of diking. In several sections there are extensive areas of diked meadows that have been producing hay in abundance for over a century. Dairying of

recent years has been increasing. Oats is the principal grain crop, and potatoes the principal cultivated field crop. The province is well adapted to the keeping of sheep.

Prince Edward Island. — Prince Edward Island lies in the Gulf of St. Lawrence, to the north of Nova Scotia and to the east of New Brunswick. It is an island 150 miles long by from 9 to 30 miles wide. All parts, therefore, are within close proximity to tidal water. The land is rolling and all adapted to agriculture. It is the smallest province of the Dominion, having an area of only 2000 square miles, of which 85 per cent is in farm lands. Eighty per cent of the people are engaged in agriculture. Pasture, hay, oats, and potatoes are the principal field crops. There is a fair amount in orchards producing apples, plums, cherries, and small fruits. There are about 14,000 farms and farm lots on the Island. The country is exceedingly well adapted to dairying and sheep-raising.

New Brunswick. — New Brunswick has an area of about 28,000 square miles, of which only one-quarter is in farm lands. Extensive spruce forests cover the remainder of the province. In the southern part there are long stretches of diked meadow lands. Hay and oats are the principal field crops, though potatoes are grown and exported. There are about 35,000 farms. The improved land is about 1,500,000 ac. in extent, and of this one-half is hay and pasture land. Apple orchards are to be found in the valley of the St. John River. Dairying is carried on to a considerable extent in the southern and south-eastern district. There is opportunity for great development in both dairying and fruit-growing. Lumbering and fishing have attracted so much attention in the past that agriculture has not been developed as the resources of the province warrant.

Quebec. — Quebec is a very large province, having an area of nearly 350,000 square miles, but the immense northern territory is largely unknown except to the hunter and the prospector. The farm lands are confined to the valley of the St. Lawrence and a portion of the valley of the Ottawa, and the area lying south of the St. Lawrence adjacent to the United States. The latter section is known as 'the Eastern Townships'. This has been farmed largely by English-speaking farmers; the former by French-speaking farmers. The methods of farming of these two sections will, naturally, show many lines of difference. Less than 7 per cent of the province is in farm lands. Many thousands of the French-Canadian population have followed the Canadian Pacific Railway north and west, and taken up large areas of farm lands in Ontario and in Manitoba. Hay and pasture are the main crops. Among cereals, oats is the principal crop, very little wheat being sown. Dairying is an important industry; some cheese being made, but principally butter, for which the province has a very high reputation. In the Eastern Townships fruit-growing is carried on quite extensively, apples being the main crop. In the vicinity of Montreal is the original home of the celebrated apple the 'Fameuse'. Considerable quantities of tobacco and flax are produced for domestic use. The breeds of live stock are peculiar to this province, French-Canadian horses and French-Canadian dairy cattle being quite distinct and having noteworthy characteristics. The French-Canadian farmer is frugal, thrifty, and prolific. He leads a quiet domestic life, and is apt to crowd out his English-speaking neighbour. He is a good colonizer. The consequence is that Quebec is becoming more and more the possession of the French 'habitant', and the area of his occupation is extending even beyond his original province.

Ontario.—As indicated in the tables above, Ontario is the most important province in the Dominion from an agricultural standpoint. By the general introduction of stock and the specializing of work in various districts it has a wider range of products than any other province. Along the lake front, fruit is grown in abundance and of excellent quality; in the eastern sections dairying has become the main feature; in the central counties the breeding of live stock has assumed large proportions.

Only one-seventh of the entire province is settled as yet, but the building of new railroads is opening up large areas of arable land. The northern portion consists of an immense area of clay land, watered by large rivers and covered with spruce forests. In the southern portion of the province, owing to the contiguity of the great freshwater lakes, a varied climate results, giving variety to the agricultural industry.

Fruit-growing is increasing rapidly. Apples of finest quality are grown over a very large area, and the acreage of orchards is rapidly increasing. Plums, pears, peaches, and grapes are extensively grown in the areas best suited, land for this purpose varying from $50 to $1000 an acre according to location. Over seventy canning factories are engaged in the putting up of fruits and vegetables for export to other provinces and foreign countries.

Ontario has more breeders of pure stock than any similar area of the continent. Large importations are yearly made from the best herds and flocks of Europe. The following are the favourite breeds:—Horses: Clydesdales and Shires; cattle: Shorthorns, Ayrshires, Holsteins, and Jerseys; sheep: Shropshires, Southdowns, Leicesters, Oxfords, and horned Dorsets; swine: Yorkshires, Berkshires, and Tamworths. Poultry-raising is extending very rapidly.

There are 1200 cheese factories, producing over 150,000,000 lb. annually of Canadian cheddar cheese, of which the larger portion is exported to Great Britain.

The table on p. 83 gives a fair statement of the growth of agricultural production in ten years.

The above figures are taken from the reports of the Ontario Department of Agriculture, which collects and publishes annually a statement of the farming operations of the province.

Manitoba, Saskatchewan, and Alberta.—These three prairie provinces may be considered together. The great prairies of the mid-continent present a greater variety than is generally

	1896.	1907.
Wheat—acres	1,131,416	820,678
,, —bushels ...	18,597,763	18,019,142
Oats—acres	2,425,107	2,932,509
,, —bushels	82,979,992	83,524,301
Barley—acres	462,792	766,891
,, —bushels ...	12,669,744	21,718,332
Hay—acres	2,426,711	3,289,552
		1906
Live stock on farms	$96,857,566	$183,307,394
Swine sold	$10,022,525	$22,501,028
Cattle sold	$12,381,248	$27,205,105
Cheese made	$8,646,735	$17,417,757
Total farm values ...	$910,857,566	$1,189,119,120

supposed, and hold out wonderful possibilities to the settler with limited capital who will adapt himself to the peculiar conditions of prairie life. Between the great lakes of Ontario and the mountains of British Columbia lies an area of over 600,000 square miles, having a population at present of about 800,000. It is essentially a wheat-growing country, probably the greatest continuous area of the kind in the known world. What it will become, what population it will sustain, and what limits may be set to its production are subjects of much speculation and controversy. Opinions differ even among those familiar with it, but with only one-sixth of its area in wheat at 20 bushels per acre it would produce a quantity equal to one-half of the present world's production. Railroads are being built in many directions, and new areas are being opened up every year. Wheat-growing is the first consideration, but mixed farming is soon taken up. The fattening of stock and the production of butter and cheese are increasing. Fruit-growing may never assume very great proportions.

The population is growing rapidly, as the following figures prove: 1871, 43,228; 1881, 87,775; 1891, 219,305; 1901, 419,512; 1906, 808,863. Settlers are coming in from many countries. In 1906 the nationality was as follows: Born in the British Empire, 70·21 per cent; born in the United States, 11·22 per cent; born in other countries, 18·57 per cent.

From the head of the great lakes, a point well on towards the centre of the continent, the isothermal lines take a great sweep to the north-west. The area of plant growth widens, therefore, as one approaches the mountains. The consequence is that wheat of the highest quality and of generous yield is being grown well up towards the Arctic circle, and before many years there may be extensive farm areas lying well to the north of Edmonton, the capital of Alberta. Though this great mid-continent area is mostly prairie land, it is much diversified and presents possibilities of mixed farming. The soil, for the most part, is a deep rich vegetable mould capable of being cropped for many successive years. Here and there are great rivers whose valleys are well wooded. Level stretches of country give way to rolling lands and this to hills, making a varied landscape. The winters are steady, and on the first disappearance of the snow, farm operations begin, the thawing of the subsoil giving moisture that sends the grain up in rapid and luxurious growth. Over considerable areas the rainfall is light, but extensive irrigation works are being constructed, bringing great streams of water from the never-failing reservoirs of the mountains. In southern Alberta millions of acres are now being irrigated and being brought into condition for growing fall wheat, oats, flax, sugar beets, and similar crops. Ranching is carried on extensively in Alberta, though the taking up of wheat land is somewhat restricting the roaming of stock. One point further needs to be mentioned as important in explaining the successful farming of this great north-west country. The summer days are long. As we go north the shortness of summer is compensated for by the length of daylight—the hours of sunshine are ample to bring grain crops to full maturity.

A special census of these three provinces was taken in 1906, and the following table is compiled therefrom:—

	Manitoba.		Saskatchewan.		Alberta.	
	1901.	1906.	1901.	1906.	1901.	1906.
Population:—						
Rural	184,775	227,598	77,013	209,301	54,033	127,379
Urban	70,436	138,090	14,266	48,462	18,989	58,033
Total	255,211	365,688	91,279	257,763	73,022	185,412
No. of farms	31,812	36,142	13,380	55,971	9,433	30,286
Live Stock:—	No.	No.	No.	No.	No.	No.
Horses	163,867	215,819	83,461	240,566	93,001	228,534
Milch cows	141,481	170,143	56,440	112,618	46,295	101,245
Other horned cattle ...	208,405	350,969	160,613	360,236	329,391	849,387
Sheep	29,464	28,975	73,097	121,290	80,055	154,266
Swine	126,459	200,509	27,753	123,916	46,163	114,623
Field Crops:—	Ac.	Ac.	Ac.	Ac.	Ac.	Ac.
Wheat	1,965,193	2,721,079	487,170	2,117,484	43,103	223,930
Oats	573,848	931,282	141,517	901,646	118,025	476,511
Barley	139,660	336,986	11,798	77,573	11,099	108,175
Flax	14,404	16,501	—	108,834	—	6,484
Potatoes	16,042	20,825	—	16,628	—	13,267

In Manitoba and Saskatchewan the wheat is all spring wheat; in Alberta fall or winter wheat is grown as well as spring wheat. The area of flax in 1901 in the two provinces of Saskatchewan and Alberta combined was 327 ac., and of potatoes 9925 ac.

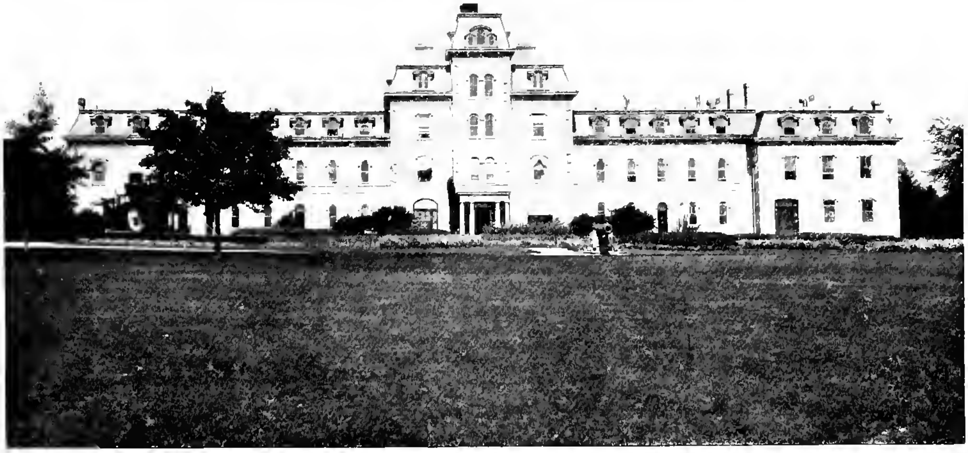
British Columbia.—British Columbia is the largest of the provinces, having an area of 382,000 square miles. Parallel ranges of high mountains run throughout its entire length. Agriculture is confined to the rich valleys and bottom lands. Some ranching is carried on. Dairying and fruit-growing, however, are the main lines of industry. Lumbering, fishing, and mining have attracted the attention and the capital of the people to such an extent that the agricultural possibilities have been somewhat overlooked. Farm lands, as a rule, are high-priced where the best shipping facilities are found. Less than two-thirds of 1 per cent of the country is occupied as farm lands. The climate is much moderated by the Japan currents. Growth is rapid, vegetation is luxuriant, trees come into bearing early. Agriculture has been much retarded owing to the lack of cheap labour. Fruit-raising in British Columbia, the growing of apples, plums, cherries, and peaches, is one of the most attractive lines of work for men with moderate capital.

Education and Experiments.—The Dominion Department of Agriculture maintains an Experimental Farm at Ottawa, Ontario, with six branch farms in other provinces (Nappan, N.B.; Brandon, Manitoba; Indian Head, Sask.; Agassiz, B.C.; Lethbridge, Alta.; and Lacombe, Alta.). Agricultural colleges are conducted as follows: At Guelph, Ontario, by the Ontario Government; at Winnipeg, Manitoba, by the Manitoba Government; and at Truro, N.S., by the Nova Scotia Government. The Macdonald College of Agriculture at Ste. Anne de Bellevue, Quebec, near Montreal, has recently been munificently endowed by Sir William Macdonald. Dairy schools are conducted in Manitoba, Ontario, Quebec, and New Brunswick, and a horticultural school is open in Nova Scotia. The various provincial Departments of Agriculture have in operation many lines of work for instructing and assisting the farming industry; there is probably no other country in the world better served in this regard.

There is a Minister of Agriculture for the Dominion of Canada, who, through a well-organized department, directs agricultural matters connected with trade and transportation. Each of the provinces has a Minister of Agriculture, who, through his department, directs the educational side of agriculture. Reports and bulletins of varied nature relating to all phases of agricultural work are published and distributed free of cost. Farmers are well organized in Canada: agricultural societies, horticultural societies, farmers' institutes, live-stock associations, fruit-growers' societies, &c., being found in all the provinces. The Dominion Department of Agriculture controls the census of the Dominion, and the Departments of Agriculture in Ontario, Manitoba, Saskatchewan, and Alberta publish annually bulletins and reports containing statistics of crops, live stock, and farm values. These publications may be had by addressing the Department at the capital of Canada (Ottawa, Ontario), or to the Department at the capital of any of the provinces (Halifax, N.S.; Charlottetown, P.E.I; Fredericton, N.B.; Quebec, Que.; Toronto, Ont.; Winnipeg, Man.; Regina, Sask.; Edmonton, Alta.; Victoria, B.C.).

[C. C. J.]

Canadian Cattle.—A great deal of attention has been directed to those cattle on account of the pleuropneumonia controversy, and the closing in 1892 of British ports against stores from the Dominion. In the early 'seventies of the past century a few small lots of Canadian cattle were landed in this country. By 1884 the total landed was over 50,000 per annum, and a few years later a considerable impetus was given to the store section of the business when feeders in such areas as Norfolk, South Lincoln, Berwick, East Lothian, Fife, Forfar, East Perth, and parts of the North-east and North of Scotland began to secure larger profits than the normal from finishing the big-framed and generally fairly bred Canadian stores for the fat markets. Most of these cattle were shorthorn grades. Between 1891 and 1892 the landing of the stores was at the rate of about 120,000 per year. A crisis occurred in 1892. On 6th October of that year some 1200 cattle, landed a week previously at Dundee by the *Monkseaton* and the *Hurona*, were sold by auction. Among these was a cow which had calved on board one of the vessels. That animal, which was purchased by a north of Fife farmer, was the cause of all the subsequent trouble. It was suspected to have caught a chill. The local veterinary surgeon diagnosed pleuropneumonia. The animal was killed and its lungs were despatched to London, where they were examined by the veterinary experts of the Board of Agriculture and pronounced to be affected with pleuro. All the in-contact cattle on the Fife farm were then ordered to be slaughtered. The cargoes from the two boats were promptly traced, and for several weeks the work of stamping out proceeded with vigour and at great expense. In opposition to Professor Brown and his colleagues on the advisory staff of the Board of Agriculture, the late Principal Williams, Edinburgh, and Mr. Jas. Clark, F.R.C.V.S., Coupar-Angus, maintained that the case on which the slaughter order had been founded was simply non-contagious bronchopneumonia, or 'corn-stalk disease'. All the cattle slaughtered by order of the Board were, with two or three exceptions, found to be free from suspicion of disease. That was the last of Canada's store cattle dealings with Britain. The cause of open ports was taken up with great energy by feeders, harbour boards, and various associations during 1893–4 and succeeding years, but with no effect. In 1896 discretionary powers in possession of the Board of Agriculture for the regulation of import trade in live cattle, sheep, and pigs came to an end by special statute. Since the 1st of January, 1897, all meat-producing farm animals permitted to be landed at British ports from abroad have had to



MAIN BUILDING, ARTAXIO AGRICULTURAL COLLEGE,
GUELPH, PROVINCE OF ONTARIO

MAIN BUILDING, MACDONALD COLLEGE OF AGRICULTURE,
PROVINCE OF QUEBEC

be slaughtered at the wharf abattoirs within ten days of disembarkation. Three or four years after the closuring of the Canadian store cattle trade it was not seriously contended by any responsible authority that the Dominion showed traces of disease, although there were doubts in some quarters regarding sections of the States. The long boundary line of Canada and the danger of introducing disease from the States have been referred to by successive British Ministers of Agriculture and their supporters as arguments against amendment of the 1896 Act in favour of Canada. Against the voting strength of the 'open port' feeders and their business friends, there has been arrayed a powerful combination representing the general breeding interest of the three kingdoms.

[J. CA.]

Canadian Goose.—Distributed throughout Canada and the northern sections of the United States is a small-sized goose designated under the above name, where it is bred to a considerable extent, though not so much as formerly. It is descended from the ordinary wild American goose crossed with domesticated breeds. As might be expected from these circumstances, Canadian geese are very hardy, which is a great consideration under the conditions which prevail in North America, and as they are quick growers, producing a large quantity of flesh, they meet with great acceptance. But for the fact that they retain the original wild nature to a large degree, which means lessened control by the owner, and that they are small in size for this species, they would be more popular in Europe. In appearance the Canadian goose differs from the best-known European races in that the body and neck are long and slender—so much so in the last named that at one time it was thought they were related to the swan rather than the wild goose. The breast whilst deep is narrow, but the sternum muscle is thick in order to work the large, powerful wings. The breast and under parts of the body are grey or greyish-white, the back and wings greyish-brown, and the rest of the plumage black, not, however, brilliantly so. One peculiarity is that from behind the eyes there passes around the chin and throat a broadening band of white, from which is derived the French name 'Cravate' given to this breed. The bill and legs are black. As already mentioned, these birds are smallish in size, ranging from 10 to 16 lb. See GEESE, BREEDS OF.

[E. B.]

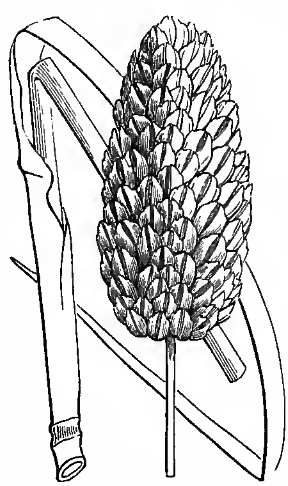
Canal. See IRRIGATION.

Canary Grass and Seed.—Botanically, this annual grass is known as *Phalaris canariensis*. It is easily distinguished from other grasses by the egg-shaped ear shown in the figure. The glossy seeds are well known under the name 'canary seed', and are used for feeding canaries. The ears themselves are very ornamental, and often used for filling vases.

With good field cultivation the plant attains a height of between 3 and 4 ft.; the heads or ears contain upwards of one hundred seeds; and the produce varies from 30 to 40 bus. per acre. The stalk or straw is hard and woody, and not of much value, either as fodder or bedding for cattle, but the husk from the ear is good food for horses, especially when mixed with other kinds of chaff.

A deep and adhesive soil is most suitable for the growth of Canary Grass; still, a crop of it may be procured wherever a good crop of wheat might be expected; but it is utterly useless to plant it on poor and ill-conditioned soils.

REED CANARY GRASS (*P. arundinacea*).—In alluvial marshes, on the banks of rivers, and by the sides of lakes, ditches, and rivulets, this is a common perennial grass throughout Britain at altitudes under about 1000 ft. It is also common in Southern and Central Europe, but is bounded in its northern range by lat. 59° or 60°, and it has not hitherto been discovered in either North or South America. It varies in height from 3 to 6 ft.; flowers in the middle of July, and ripens its seeds about the middle of August. In its growth the Reed Canary Grass presents a coarse and somewhat forbidding appearance, producing an abundance of long, broad, harsh foliage on its fertile, as well as on its numerous barren or leafy stems, which in its more matured state is generally avoided by horses and cattle having access to more agreeable and nutritious pasturage; but in its earlier stages these animals devour it readily, more especially when cut and used for soiling or house-feeding, under which treatment it will afford two or three heavy crops during summer and early autumn. It is inferior to most grasses in late autumnal growth, becoming, when left in its natural state, rigid and withered before winter, and remaining so during its continuance, thus affording agreeable cover for wild ducks, snipes, and other denizens of its native habitats.



Canary Grass (*Phalaris canariensis*)

Under certain circumstances Reed Canary Grass has considerable value as a litter plant. In mountainous districts, on wet tenacious clays, and wherever there is scarcity of straw, attention should be given to it.

About 12 lb. of pure germinating seed suffice to cover an acre. The plant may be propagated by transplanting pieces of its underground stems, which should be done at distances of about 1 ft. apart, in early spring, on ground previously well prepared and pulverized by the winter frost; and in all cases the produce will be materially increased by judicious irrigation. Reed Canary Grass is further useful for protecting the banks of lakes and running streams from water encroachments.

A variety of Reed Canary Grass having white stripes in the green leaves is often seen growing in gardens, where it is known as Ribbon Grass or Gardener's Garters (*Phalaris arundinacea* var. *picta*). Variegated Cocksfoot, having the same leaf peculiarity, is also commonly grown for ornament. Although Cocksfoot and Reed Canary Grass are often confounded, distinction is perfectly easy, for Cocksfoot has a broad, flat shoot, and Reed Canary Grass a cylindrical stout one. [J. L.]
[A. N. M'A.]

Cancer.—Malignant growths known as sarcoma, epithelioma, carcinoma, and under other scientific descriptive names are not easily distinguished except by microscopic examination by a pathologist, and though fortunately not very common among animals, cannot be said to be rare. The observant layman will, however, notice that such cancerous growths do not determine to a point, as is the case with an abscess, or attain a crisis and disperse, or become inert or calloused, nor is there any defined line between the healthy and morbid tissues. They convert to their own substance whatever they invade, be it soft or hard, muscle or bone, and are usually slow but remorseless in their progress, frequently producing secondary growths in other parts of the victim, and inducing constitutional effects apparently disproportionate to the visible tumour and such pain or inconvenience as it may be supposed to give rise to. The cause or causes of cancer are not known. Neither are we able to say if it is infectious; but having regard to the similarity of structure or pathological elements in man and beast, the importance of segregation and careful handling should be impressed upon persons having the care of such patients. The milk of a cow suffering from cancer should not be consumed by any other creature. Custom has hitherto sanctioned the consumption of carcasses from which cancerous growths have been removed, but this concession to the unfortunate owner will, it is expected, be shortly denied, and compensation granted out of the public purse. There is no species of animal exempt from cancer, and carcinoma has been found endemic among wild rabbits. Carcinoma and sarcoma are the more frequently found in bovines, and among equines, epithelioma affecting the penis.

Treatment consists in surgical removal of growths where possible. If the malady is sufficiently early recognized, extirpation may be successful, and before secondary infection has occurred. The comparatively short time required to fatten a beast, or at least make a marketable carcass, enables the owner to dispose of a bullock without serious loss. In the case of horses, amputation of the affected portion of the penis is very commonly followed by a period of usefulness before any recurrence of the growth appears, and in some cases a permanent cure has been recorded. [H. L.]

Candle.—Candles are chiefly made from tallow, which may be either pure or mixed with some essential oil, spermaceti, or wax. Paraffin is a common material. The farmer, if far from any town, may make his own candles. The cotton from which the wick is made is sold in balls. Several strands of equal length are cut off and twisted together to form the wick. The wicks may then be affixed to a stick and the whole dipped into a large deep vessel filled with molten tallow. After the second immersion the candle is allowed to dry on a rack and then dipped again, the process being repeated until the requisite thickness has been achieved.
[R. H. L.]

Candytuft. See Iberis.

Canker of the Ear.—Canker is a term loosely applied to any inflammatory disease of the ear of the dog or cat in which there is a discharge, an ill odour, a swelling, or a sore. An external and internal canker have been described. That which is meant by external canker is either a serous abscess (see Abscess) or an established ulcer of the flap, caused and continued as a result of shaking the head violently. There are acute but passing inflammations (*otitis*) which give rise to an unpleasant smell, and are easily curable with a few liberal dressings of zinc ointment. The term 'canker' should properly be reserved for an ulcerated condition of the inner lining and cartilage subjacent to it. These internal ear troubles may be assigned to two principal causes, namely, the entrance of grit and accumulations of wax and broken hairs, desquamated cuticle, and foreign bodies; and to a far more frequent but not recognized one, the presence of parasites of the mite type (*Symbiotes auris*), which find a home in the soft meatus and delight in the sebaceous and ceruminous secretions. They are discernible at times with the naked eye as white or greyish spots, and appear to move at irregular intervals in groups or colonies, causing the greatest irritation and alarm to the patient. Cats are often supposed to be in a fit when they dash across a room and hide under furniture at such times, and dogs strike the base of the ear with the hind foot to allay the intolerable itching, and only succeed in making wounds outside, and setting up serious inflammatory action within. To subdue this, the cause must first be removed. An ointment of 1 part of nitrate of mercury ointment to 20 parts lard, worked into the convolutions of the ear for two or three nights in succession, may be relied on to destroy the parasites; after which the ear should be cleaned out with cotton wool, and a lotion daily applied of oxide of zinc and glycerine in water, or the zinc ointment of the Pharmacopœia. No cap or covering should be worn, this being reserved for ulcers on the flap of the ear (external canker so called). These ulcers usually need some slightly stimulating application, as a weak sulphate of zinc or copper solution, and later the zinc ointment already advised for the internal trouble. If the animal can be prevented from shaking the head, healing may be looked for.
[H. L.]

Canker of the Foot.—The horseman applies the term canker to a disease of the foot, and the dog-owner to an ear trouble (see above). Both are associated with an evil odour. Canker of the foot is a chronic inflammation of the horn-secreting structures of the foot, with a tendency to

invade and infect fresh areas. The horn papillæ, from which true horn is produced in the normal subject, become enlarged, as does the tissue connecting it as a network of vessels (the rete), active increase taking place in their cellular elements. The epithelium produced does not arrive at the stage of horn, but breaks down into a greasy grey fluid, with a wellnigh intolerable odour. Pathologically, it is identical with the disease called grease (see GREASE). Canker may be a sequel to neglected thrush, or originate as a little eminence on the frog, with the characteristic greasy appearance and smell. The absence of lameness during the initial stage causes the disease to be overlooked in any but the best-managed stables. Unless detected and energetically treated, the malady spreads almost imperceptibly from the frog to the sole and bars, finally affecting the walls, and scaling them even to the coronet. Penetrating invariably between the horny and sensitive structures, it eventually separates them. The sensitive laminæ produce exuberant fungoid growths, and when this stage is reached the disease may be regarded as incurable. The cause of canker is not known, but is supposed to be an infection which cannot be ascribed to a single organism but to several.

Treatment.—The prospects of success depend upon the stage the malady has reached, the area involved, and the predisposition as evidenced by the number of feet involved. The softer and more rapidly spreading cases, in which there is loss of shape in the papillæ, offer the least hope of cure. Much time and patience will be needed in all cases by the patient, the owner, and the surgeon. The broken-down horn and fluid discharge have to be removed by scraping and mopping, or the knife, and the essence of any treatment to be of use is the arrest of the secretion by a variety of caustic agents, and the application of pressure by mechanical means. Nitrate of lead has the best reputation, but changes should be made from time to time, and no case should be regarded as cured until every part is dried off and healthy horn is again being secreted. Bar shoes tightly packed, and wedged by pieces of hoop iron, and moderate work, are advised, unless lameness is such as to forbid us on humanitarian grounds. [H. L.]

Canna, a genus of herbaceous plants with tuberous roots which belongs to the Scitamineæ. The commonest tropical form is *C. indica*—the Indian Shot—a name given because of the hard, round, black, and very abundant seeds which it affords being often used as pellets. Many of the cultivated forms now met with in Europe came, however, from Peru and Brazil. They are brightly coloured yellow, orange, red, and in some species the foliage is quite as attractive as the flowers. They are favourite plants for bedding out, require light rich soil, and may be propagated by root cuttings or by seed.

[G. W.]

Cannabinaceæ.—This is the botanical name for the order of dicotyledonous plants which includes the Hemp and the Hop. The distinctive characters are: (1) The flower has no petals; (2) the male flowers are on one plant and the females on another; (3) the plants are herbs with palmately veined and stipulate leaves. The cultivated plants of the order are: HEMP (*Cannabis sativa*), an erect annual cultivated for fibre, fruit (called Hempseed), and in Eastern lands for the narcotic resin used in the preparation of hashish. HOP (*Humulus Lupulus*), a herbaceous twining perennial. The females are cultivated for their cone-like fruits, which are the Hops of commerce. See next art.

[A. N. M'A.]

Cannabis.—This genus is remarkable as that to which the Hemp (*C. sativa*) belongs (see preceding art.). Originally wild in northern India, it is now widely cultivated in all parts

Hemp Plant (*Cannabis sativa*)

1, Female. 2, Male flower. 3, Female flower. 4, Fruit.

where it will grow. It attains a height of from 4 ft. to 10 ft. or even more. Italian Hemp is regarded as the best; the fibre is obtained from the stems, which are soaked in stagnant water to separate the fibrous bark from the useless portion. Hemp is a common material from which ropes, mats, canvas, sacks, &c., are made. The leaves of the Hemp plant are used in India for smoking and are known as bhang. The dried flowers are also used for smoking and are known as ganja. The plant is grown in gardens for its ornamental appearance. The seeds are used for feeding cagebirds.

[W. W.]

Cantal Cheese, a commonplace but at the same time a practical and economic cheese of France, made in the mountainous districts of Aubrac and the Auvergne. It is economic, inasmuch as it utilizes the herbage — as in Switzerland—of localities otherwise unsuited to profitable occupation. It may be regarded, like the Emmenthaler (or Gruyère) of Switzerland, as a product of the hills in its origin,

though its manufacture is not at all necessarily confined to such localities. As a matter of choice it can be equally well produced in the lowlands as on the uplands; but as a matter of economy it is chiefly made in the hilly regions. And indeed, these mountain dairies, situated as they are in the midst of pure and invigorating air, tending alike to plenary health and vigour of man and beast, supply opportunities for the production of cheese whose quality and flavour possess uniformity of character—a point which has an unfailing monetary value in the market. These advantages, however, are too often neglected.

The process and equipment employed in the manufacture of Cantal cheese are primitive, as may be expected under the circumstances; and as there is no effort made to secure uniformity of method, the cheese varies more or less in character. The chief feature in the process is the plentiful kneading which the curd receives from hands and knees, the object of which is to maintain temperature in the curd, and by so doing to secure what is considered to be an agreeable flavour. [J. P. S.]

Canter.—The pace known as the canter is one affected by ladies, and by horsemen as an easement on long journeys, as it permits the rider to sit back in the saddle without rising and falling to the movements of the animal, as required by the pace known as the trot. Provided that the leading leg is changed at frequent intervals it is not specially tiring. If the change is attempted while turning, the animal's legs are liable to cross and bring him down. A properly trained lady's hack will change legs on being lightly stroked down the shoulder with the rider's whip. To have a correct conception of the movements of the horse's limbs in this pace, one must lay aside the received interpretations of the most famous artists, and accept the evidence of the camera and highly sensitized plate, by which every stage of every movement has been faithfully recorded. The canter is a pace of three-time, in which we must count from one or other foot, as, for instance, (1) off hind, (2) off fore and near hind, or off fore, followed by the near hind, and (3) near fore, which may or may not be followed by a period of suspension before the horse again brings down his off hind leg. In the light-bred horse there will be what Captain Hayes has spoken of in the movements above quoted as a moment of suspension, when the animal is not touching the ground at all. There is also a period when the animal's whole weight is imposed on a single hind foot, and for this reason the pace is considered to be a wearing one for horses, and not to be continued for any length of time, but as a change from other paces. If a heavy cart horse is made to canter slowly, a quick eye can follow his movements with more or less accuracy. [H. L.]

Canterbury Bell.—This is perhaps the most ornamental species of the Bluebell order (Campanulaceæ). It is a tall biennial with very large bluish flowers. In varieties the colour may be white, or rose, or pure-blue; double varieties also occur. The botanical name is *Campanula Medium*; the distinctive features are the intersepaling lobes of the calyx, the five-chambered ovary, and corresponding therewith, five stigmas at the end of the single style. [A. N. M'A.]

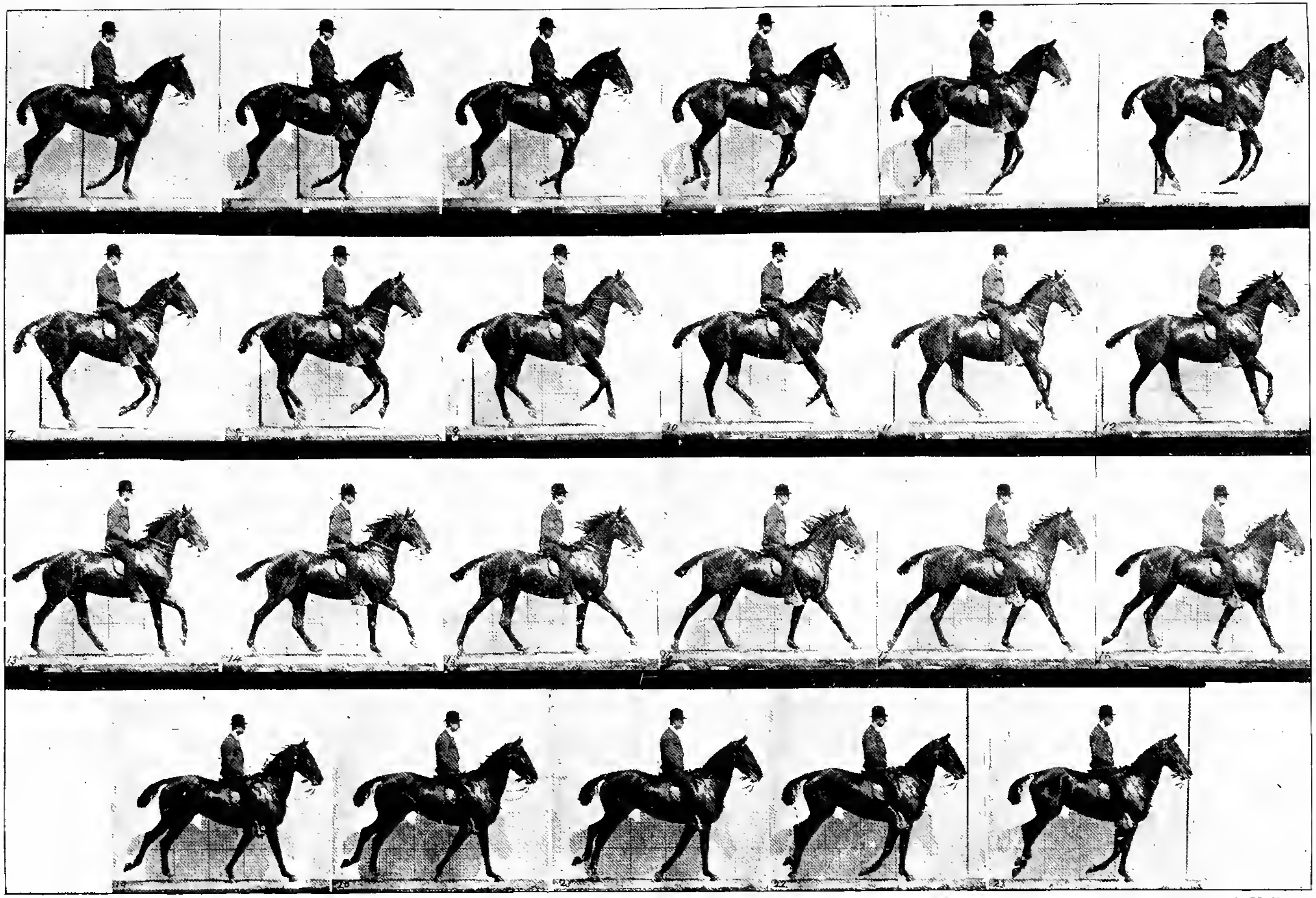
Canterbury Hoe.—The Canterbury hoe is not strictly a hoe but a hooked fork, known in many districts as a muck drag or muck hook,

Canterbury Hoe

used to drag manure from cattle sheds or from the cart when taken to the field. It is frequently used in the hop fields in working round the hop hills; also for dragging couch from land under ridge cropping or during fallow cultivation. [W. J. M.]

Canvas Sheds.—Canvas sheds are useful to provide temporary shelter, and good examples of these can be seen in the larger show yards, where they are extensively used. Canvas shedding is useful for protecting young plants in pots from frost, and has been found to be especially so with tomatoes and potatoes. When used for this purpose, means should be provided to allow of the shelter being thrown open during the day, and closed at night when frost may be expected. In flower-farming it is not unusual to cover large areas with tiffany to prevent injury from frost. This is sufficiently thin to permit many sun's rays reaching the tender plants; at the same time it breaks the effect of winds, and is sufficient to check freezing. When used on a large scale it is usual to mount it on supports sufficiently high to allow horses to work freely under it. An ordinary rick cloth mounted on the usual ropes and poles, raised and lowered at will, may be used to protect a very large number of small plants. Canvas shedding is used largely as temporary shelter for young lambs in the lambing yard and when first taken from the yard. It is very easy to set up, and on the whole economical to use. [W. J. M.]

Caoutchouc, Indiarubber, or simply **Rubber,** may be defined as an inspissated milky juice (latex) obtained through tapping (by incisions made in the bark) certain tropical trees, shrubs, or climbers. It consists of the corpuscles of a hydrocarbon floating in a fluid which contains in addition albumen and other undesirable ingredients. The process of purification consists in what is called the coagulation of the albumen, which thus carries with it certain of the impurities, and prepares the way for the subsequent agglutination of the hydrocarbon. Hence caoutchouc may be spoken of as the chemical term for the hydrocarbon, but it is also popularly used to denote the purified commercial product, while indiarubber is the impure article. Gutta-percha differs almost exclusively in being in-



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THE CANTER

elastic and in its softening at low temperatures; it becomes plastic in hot water, and retains on cooling the form then given to it. Caoutchouc is distinctly elastic, is lighter than water, has neither taste nor smell, is fusible at about 248° F., and inflammable at higher temperatures. Botanically, indiarubber is obtained from three groups of plants, placed in the Euphorbiaceæ, in the Urticaceæ, and in the Apocynaceæ, while gutta percha, is derived almost exclusively from plants which belong to the Sapotaceæ. There are thus no botanical affinities in the plants that afford these products, and hardly any other resemblances than that they are one and all milk-giving plants found in tropical countries.

The commercial article may be said to consist chemically of two ingredients—an elastic material, on which its merit depends, and a resinous substance (readily oxidizable), to which its depreciation is mainly attributable. The relative proportions, therefore, of these two ingredients give the first direct evidence of merit or demerit. The special characteristics of the elastic principle also vary greatly according to the species of plant from which derived. But while the chemistry of the latex must receive the foremost consideration, much depends on the methods of tapping pursued, and the care and cleanliness bestowed on the subsequent manipulation of the commercial article. The question of the profitable production of rubber therefore turns very largely on the following considerations: (1) A milk rich in elastic rubber; (2) a quick-yielding species of plant; (3) a climate and soil favourable to a generous growth and liberal supply of latex; (4) superior and cleanly methods of tapping and subsequent manipulation; and (5) the price obtainable for the article so produced.

Particulars need only be here afforded of a few of the better-known rubbers of commerce, since these practically give the guiding lines in the production of all the others.

1. Para Rubber is the original and to this day the most important form. It is derived from *Hevea brasiliensis* and perhaps two other allied species (Euphorbiaceæ), a lofty tree of Central and Northern Brazil, more especially the forests of the lower Amazon and its islands. The region in question is remarkable for its uniformity of climate (mean temperature 81° F., maximum 95° F.), and for a rainfall from January to June, the greatest amount (15 in.) falling in April. With the rise of the rivers the land frequently becomes inundated, and the soil is, moreover, very retentive of moisture. The trees grow rapidly, attain a height of 30 ft. in three years, and may be tapped for rubber when six years old. Once established, Hevea requires little attention. When tapping takes place, the bark of the trees should be carefully cleaned. Deep V-shaped incisions are then made in the bark and carefully cleaned before the flow of milk begins. Dust, sand, particles of wood, and other impurities greatly lower the value of the rubber and have to be guarded against. The milk flowing along these converging vertical channels is caught at the lower end in vessels specially provided for the purpose. By exposure to air it thickens slightly, and was formerly then laid on clay moulds, which were suspended over a slow, smoky fire. When the first coating had become dry a second was spread over the top, then smoked and dried. This was repeated time after time till the desired thickness had been obtained. Finally the rubber was removed from the moulds, and constituted the dark-coloured moulded 'biscuit' or 'bottle' rubber of commerce. More recently the partly dried rubber is simply spread over the blade of a paddle and thrust into the smoke of the fire, earthen moulds not being now used.

Efforts have been made to extend the cultivation of this most valuable tree into all countries found suitable. It is the universal opinion, in fact, that where Hevea can be grown it is undesirable to attempt the cultivation of any other rubber plant. The world's supply now comes from Brazil, Peru, the Straits Settlements, West Africa, Ceylon, and Burma. Some conception of the magnitude of the present-day traffic in this rubber may be had from the fact that the exports from the Amazon valley in 1864 came to close on 8,000,000 lb., and forty years later (1904) were 67,000,000 lb.—a quantity, assuming that it was all obtained from the present species, that would represent the systematic tapping of 20,000,000 trees and have fetched £13,000,000 sterling. The total imports in 1907 into Great Britain from all sources and of all kinds of rubber came to 667,294 cwt., valued at £10,834,759. Of that amount Brazil alone contributed 285,806 cwt., and the British possessions collectively 104,772 cwt. The Brazilian rubber is doubtless very largely Para, and of the supply from the British possessions three features are of special interest—the expansion of the contributions from the Gold Coast, from Nigeria, and from the Straits Settlements. The supply from these three sources expanded from 20,960 cwt. in 1902 to 81,795 cwt. in 1907. In Africa, the Federated Malay States, Ceylon, and India a vigorous effort is being made to participate in this great modern demand for Para rubber, and so far the result has been most gratifying—a consequence very largely of the care bestowed on the preparation of the raw product.

2. Ceara or Manicoba (the Scrap Rubber of Commerce).—This is obtained from *Manihot Glaziovii* (Euphorbiaceæ), a thick-stemmed low tree, native of Brazil, especially Ceara. Unlike the Para, it frequents a region that possesses a dry arid climate for a considerable part of the year; the temperature would seem to range from 82° F. to 90° F., and the altitude to be about 200 ft. above the sea. It is readily propagated by seed or cuttings, is very hardy and fast-growing, needs next to no care, and when once established gives a remunerative crop on poor, dry, rocky soils almost unsuited to any other plant. It yields a good rubber, second only to the best Para, very elastic, free from stickiness, and is usually coagulated into tears; hence the trade name 'Scrap'. The quantity is, however, small, but the return earlier than with any other rubber-yielding plant. It may

be tapped twice a year, and yields a supply for fifteen to twenty years. This plant therefore seems to call for renewed efforts toward its extended production.

3. Castilloa or Central American and West Indian Rubber.—This is obtained from one of the largest forest trees of the north-east coast of Mexico, Honduras, Guatemala, Nicaragua, &c. There are two species that yield it—the Mexican, now also grown in India, Ceylon, &c. (*Castilloa elastica*), and the Honduras and Costa Rica plant (*C. Juna*) (order Urticaceæ). The imports into Great Britain from Central America are comparatively unimportant—a circumstance perhaps indicative of the commercial relative value of this rubber. The plant, however, has been described as intermediate between Para and Ceara, since it requires neither the tropical humidity of the former nor the dry conditions of the latter. In some localities the milk is collected by tapping living stems, in others the trees are felled and rings cut around at certain distances apart, the stems being at the same time raised slightly and a dish placed below each ring to receive the rubber. It thickens by exposure to the air, and is spread out in sheets and hung up to dry; this is the Sheet Rubber of commerce.

4. Indian and Malayan Rubber.—*Ficus elastica* (Urticaceæ)—a gigantic tree which usually sends down from its branches numerous aerial roots. It usually occurs at altitudes of 1000 to 3000 ft., and is now systematically grown both in Java and India as a source of rubber. It requires high, well-drained land, and a hot steamy climate; is raised from seed sown in January, and when 1 to 2 ft. high the young plants are transferred to their permanent positions and arranged in lines 50 ft. by 100 ft. apart. It can also be grown from cuttings made in May. Most of the rubber exported from India hitherto has been collected from wild trees and conveyed from across the frontier into Assam and Burma. But the Government of India's plantations (established in 1873–7) have recently begun to contribute a high-class rubber. It seems, however, very doubtful if this caoutchouc will pay as compared with the grades above mentioned, except as a subsidiary crop and as occupying otherwise useless land. The latex is collected during the dry months, but the trees can only be tapped once in three years, and the average age at which tapping commences is twenty-five years. Eight oblique cuts are made on the main stem, sloping downwards and at a little distance from each other. The incisions should not be deep, as the milk is secreted just below the outer bark. Underneath are placed pots to catch the milk. This is coagulated by the aid of alum, the rubber then removed and dried for about a week. As met with in the market it has commonly been rolled into balls or made up into cakes, slabs, or loaves of scrap. The yield is about 8 oz. for each tree per annum.

5. Other Rubbers (belonging to the Apocynaceæ), such as Pernambuco and Mangabeira, are obtained from *Hancornia speciosa*, a small tree native of Brazil. This is described as a wet rubber and coagulated with salt. African rubbers, such as those from Gambia, Sierra Leone, the Gold Coast, Congo, Calabar, Cameroons, Batanga, and Liberia (when not Para or other foreign cultivated rubbers), are obtained from various species of Landolphia, and in Lagos of Funtumia. Madagascar rubber is also derived from a Landolphia. The indigenous rubbers of Penang, Sumatra, Borneo, &c., known in trade as Menungan, are chiefly obtained from *Leuconotis eugeniformis*. But another group of these rubbers must still be mentioned, namely the species of *Willughbeia*—climbers that afford much of that obtained from Singapore, Sumatra, and Borneo. Lastly, *Parameria*—the Tailainy Creeper—yields the rubber of the Andaman Islands and Tenasserim, while *Urceola* gives those of Malacca, Penang, and Burma (Pegu). [G. W.]

Capercaillie, the, a bird of the order

The Capercaillie

Gallinæ; family, Tetraonidæ. The Capercaillie or Cock of the Woods (*Tetrao urogallus*) is the largest member of the grouse family. The sexes differ greatly both in size and plumage. The adult cock, which may measure 40 to 42 in. in length, has a beak coloured like white horn.

From Stereograph, Copyright,] [Underwood & Underwood

COLLECTING INDIARUBBER IN A SOUTH AMERICAN RUBBER PLANTATION

The irides are hazel; over the eye is a patch of naked skin of bright-scarlet hue. The feathers of the neck and head, which form a kind of crest and a ruff or mane, are smoky black; those on the throat and chest are smooth, of a dark shining green, and pass on the under part of the breast into black, sparsely dotted with white. On the back and rump they are dark brownish-grey, freckled with greyish-white; the wing coverts are chocolate-brown, with lighter markings; quill feathers dark brownish-grey. The tail feathers are smoky-brown with a few white freckles; the upper tail-coverts are barred with black at the end and tipped with white. The thighs are grey, with darker grey feathers on the legs as far as the metatarsal joint; the toes are naked, and, like the claws, black. The hen is a much smaller bird, measuring about 26 in. in length. Her beak is brown; irides hazel, with the characteristic scarlet patch over the eye. The general colouring of the plumage is dark-brown with freckles and bars of a lighter hue, the breast feathers being edged with greyish-white and barred with black. On the flanks and under tail-coverts the feathers have a broader white margin, and the fore part of the head and the chest display a fine rufous tint.

This noble fowl inhabits pine forests in various parts of Europe, over a range extending from Lapland to Spain, Italy, and Greece, but there are wide tracts within that compass where capercaillie are never seen. It was once indigenous in Great Britain and Ireland, but disappeared with the pine forest, lingering latest in Scotland, where it became extinct in the latter half of the 18th century. It is from that country that we have received the most detailed early account of the Cock of the Woods. Bishop Leslie, writing about 1578, has the following: 'In Rosse and Loquhaber [Lochaber], and vtheris places amang hillis and knowis [knolls], ar nocht in missing fir trie sufficient, quhair oft sittis a certane foul and verie rare called the Capercalye to name, with the vulgar peple the horse of the forrest, les indeid than the corbie [it is considerably larger], quhilk pleisis thair mouth quha eitis her with a gentle taste, maist acceptable. Sche liues of only the tuigs or tendir branches of this trie.' The laird of Glenorchy sent one in 1651 as a present to Charles II when he was in Perth, and the Black Book of Taymouth records that the king 'accepted it weel as a raretie, for he had never seen any of them'. Pennant was probably the last writer to see the capercaillie before it became extinct in Britain, stating that he saw a cock bird in 1769 from Glen Moriston, or the Chisholm's country. He also states that the species still survived in Tipperary about 1760. By the end of the century it had completely disappeared from both Scotland and Ireland; but in 1838, Lloyd, author of Scandinavian Field Sports, obtained some birds from Sweden for the second Marquess of Breadalbane, who turned them down at Taymouth. They took kindly to acclimatization, increased rapidly, and have spread from this colony to many districts in Scotland where suitable woods exist. For the capercaillie is a true woodland dweller, subsisting upon berries, acorns, &c., and the young shoots of pine, birch, and alder, scorning the attraction of cornfields. Hence it is quite harmless to the farmer, although the forester complains of the injury done to growing woods.

The capercaillie is polygamous. The cock bird performs remarkable antics in his love frenzy. Seated on the branch of a pine, he spreads wings and tail in turkey fashion, bowing and gyrating and uttering a wonderful song. The hen scrapes a slight hollow in the ground and, without preparing any nest, lays from five to twelve eggs, buff in colour, spotted with reddish-brown. Capercaillie-shooting does not take high rank among field sports. On the Continent the cocks are usually stalked and shot when they abandon their habitual wariness during the love season, but that method is not in accordance with the British sportsman's code. In this country they are shot by guns posted forward in the wood, which is beaten towards them. The largest number killed by a shooting party in a single day is that recorded by Mr. J. G. Millais, when seventy capercaillie fell to the guns in the Duke of Atholl's woods at Dunkeld. Mr. Millais was also one of a party which shot thirty-five cocks at Ballinluig, in the same district.

The flesh of these birds is not much esteemed at the late season, when they are usually shot. They are then feeding on young pine shoots and have a strong resinous flavour; but young birds, killed before the supply of berries has failed, are said to be very delicate fare, much superior to black game. Perhaps the chief merit of this, the greatest of the grouse, is the dignity and interest its presence lends to a Highland landscape. It is a fine thing to see such a large bird launch itself from the branches of a lofty pine and steer its swift flight across the valley. Hybrids between capercaillie and black game occur so frequently in Scandinavia as to have caused some naturalists to recognize them as a separate species under the name of *Tetrao medius*. [H. E. M.]

Capillaries are very minute bloodvessels which carry the blood stream to all parts of the body. See Circulation of Blood.

Capillary Attraction is the term applied to the molecular attraction of solids for the molecules of the liquids in contact with those solids. The existence of this molecular force, or surface tension, may be readily demonstrated by dipping a narrow glass tube open at both ends into water, when the water will at once be seen to rise up slightly in the tube above the level of the water outside the tube, the surface of the water in the tube assuming a convex shape. Liquids like mercury, which do not wet the walls of the vessels, assume a concave apex. If tubes of different bore are used, the height to which the water rises in the tubes will be in inverse ratio to the diameter of the tube. Salts in solution affect the surface tension or attraction of substances. For capillary attraction in soils see art. on Soils. [R. A. B.]

Capital.—No great questions of principle are involved in the definition of capital, but it

is a matter, nevertheless, upon which very considerable discussion has taken place. The peculiar difficulties in the way of agreement are that scientific needs and the usages of the market-place have to be reconciled. As to the root idea there can be no dispute: the term is the correlative of income. It has been customary, since the time of Adam Smith at latest, to distinguish between 'social capital' and 'private capital'. By the former it was most common to mean, wealth devoted to making more wealth for the community, *i.e.* to creating social income. The intention seems clear, but to the accurate mind there is a haziness about the boundaries which is disturbing. Some things — *e.g.* a farmer's saddle horse—are sometimes used for pleasure purposes and sometimes in business, to give one example. The haziness might be cleared up, it has been suggested, by the intention of the user settling whether an article is capital or not; but this suggestion would not improve matters, as the distinction would reside in the indefinite complex psychological states of individuals. 'Private or individual capital' meant the wealth which an individual used in getting an income. It obviously stood for a wider class than 'social capital', since it included consumers' goods (pianos, for example) let out on hire. But as defined above it is open to the objections already brought against the corresponding definition of 'social capital'. A proposal has recently been made by Professor Cannan and by Professor Irving Fisher to understand by 'capital' all wealth, and by 'income' the services derived from wealth within a given period. Thus the capital of a farm at any moment would be the land, the farm buildings, the stock, the seed in the ground, and all the things of value in and about the farm at the moment in question. The income derived from the farm in a year would be the services elicited from the cows, the horses, the crops, and, in short, from anything in and about the farm. My capital would consist of all the things of which I am possessed, my house and furniture included. The income from the house and furniture would consist in the uses I make of them—expressed as value, the letting value of these uses. The merit of these definitions is that they correspond closely with the practices of account-keeping, as Professor Irving Fisher in his work on the nature of capital has pointed out at length. The first defect to strike the student is the break with traditional economic usage. Commonly land, labour, and capital were referred to as the factors involved in the production of wealth. But according to these definitions land is capital, and some capital is not employed at all in production as generally understood. The second point need not be pressed, since it has long been agreed that private capital at any rate must include wealth not engaged in the manufacture of other things. As regards the first point, the objection can be removed by the employment of the phrase 'capital other than land' if it is desired to exclude land. It need hardly be impressed upon the reader that money is not capital (except as a commodity), but power to obtain capital and the measure of capital. The amount of any person's capital is, of course, expressed as value. Probably the most inconvenient loss associated with the new definition of capital is that the term could no longer be used to oppose saving and spending, and the devotion of wealth to present satisfaction and production. When, however, it is intended to convey these ideas, suitable phrases can easily be employed.

The amount of saving in a country, which closely determines the extent to which wealth is applied to future production, depends upon the *will* to save and the *power* to save. The power of an individual to save depends upon the amount of his income. The will to save depends upon the relation between his income and his standard of living, his obligations in the future and the degree in which he realizes the future, the security of savings and the amount of reward they can secure. Want of space and the limited intention of this article forbid a disentangling here of these mixed influences. Suffice it to say that in some circumstances a person's saving would diminish with a rise in interest, while in others it would increase. The latter preponderate. We may give as an example of the former a person who wishes to retire, and needs for that purpose an income of, say, £500 a year. He would have to save less to secure this income if interest were high than if it were low.

The distribution of capital among the world's economic undertakings presents many interesting problems. Capital to-day travels farther afield from the source of its saving than it did in an earlier period. The causes are increased knowledge of affairs generally, the adoption of measures for the protection of the lender, and the development of agencies for distributing capital. Savings from agriculture have fructified industry, and some of the wealth made in industry finds its way to the land.

Connected with the distribution of savings is the question of the distribution of investment among the several objects involved in farming. To explain this, the conception of the marginal returns from investment must be employed. If a farmer buys a plough, the annual value added to his product would be, let us say, £100. If he bought a second there would still be gain, but it would be less than that of the first plough, say £60. A third would add, suppose, £30 to the earnings from the farm, and a fourth £15. These sums represent what is termed the marginal returns from investment in ploughs. If four ploughs are bought, the marginal return is £15. Investment in other objects can be regarded in the same way—for instance, expenditure on labour, buildings, seed, stock, other implements, and so on. Then clearly the most economical distribution of expenditure on a farm is that which secures equal marginal returns from the several lines of investment. If the return from marginal expenditure on stock is less than that from marginal expenditure on implements, the farmer will clearly gain from checking his purchases of stock and buying more implements until the marginal returns come together. Take again the case of two

fields on one farm. A period sufficiently long to cover the complete system of working of the fields being taken, it is evidently to the farmer's interests so to work them that the marginal returns from investment in each are equal. If both are arable, the more fertile will absorb the more capital.

Capital is spread throughout the economic undertakings of a country under the direction of the same principle. Apart from differences of risk, capital will tend to be so divided among businesses that the earnings of capital are the same in all. If capital makes 10 per cent in stock-rearing and 12 per cent in market-gardening, thereafter the flow of capital into the former business will be checked, while that into the latter will expand until, by the earnings of capital rising at stock-rearing and falling at market-gardening, the earnings in the two businesses are brought together again. This has commonly been expressed by the proposition that profits tend to an equality.

The reader will now begin to perceive, no doubt, how the rate of interest is governed. Let a country have savings accumulating at the rate of £50,000,000 a year, and let them be distributed according to the law enunciated above. Apart from payment for risk, let the earnings of capital be 5 per cent. Now if 5 per cent will secure an annual saving of £50,000,000, the position imagined is one of equilibrium. But if more than £50,000,000 a year would be set by for investment were the rate of interest 5 per cent, more will be saved, and the saving will continue until what we may term the supply-price of saving equals the marginal return from the investment of savings. Interest as generally understood includes elements omitted from the above argument, but for the purposes of our demonstration now, the above presentment has a sufficiently accurate correspondence with fact.

The flow of capital between countries is naturally less mobile than its flow at home, owing to the imperfect knowledge of conditions abroad and a variety of considerations, many of which the reader will be able to think out for himself. See following arts. [S. J. C.]

Capital, Landlord's.—Under the ordinary system of landlord and tenant, the share of the former in the equipment of his property for agricultural purposes consists in dividing the farm into suitable fields by fences or hedges, in draining the land, in making a suitable road to connect the farm with the public highway, and in providing a dwelling-house and cottages for labourers, together with the necessary stables, cowhouses and cattle-sheds, barns, granaries, cart-sheds, and piggeries. The cost of all this represents the 'landlord's capital', the money invested in making the bare soil available for agricultural purposes. This 'capital' is, on the whole, in an exceedingly durable form, but it is still subject to constant depreciation, and requires constant outlay in order to keep it in a profit-making condition. In speaking, therefore, of the rent of a holding, it is important to remember that the cost of repairs and a fair interest on the money originally laid out must be deducted before we arrive at any payment for the land itself.

It is obvious that the immense diversity in the size of farms throughout Great Britain, and in their equipment as regards buildings, &c., makes it difficult to arrive at any average figure which can be used as an estimate of the landlord's capital. That it reaches a very substantial amount is evident when we consider the first cost of erecting the buildings on an ordinary farm, and of hedging, ditching, drainage, and road-making. Articles dealing with each of these items will be found elsewhere, but it will be useful to give some general indication of the average cost.

In 1860 a well-known authority, Mr. Bailey Denton, put the cost of erecting farmhouses and buildings at about £4, 10*s.* per acre on 1000-ac. farms and upwards, £6 per acre on mixed farms of 500 to 1000 ac., and £7 per acre on farms of 200 to 500 ac.

In recent years the less prosperous condition of agriculture has led to the employment of cheaper, though probably less durable materials, and the average cost has shown a tendency to decrease. For instance, Mr. Tom Bright, in his Agricultural Surveyor's Handbook, estimates that under the more economical systems of farm management of the present day the cost would be as follows:—

Approximate Size of Holding.	Cost of Farmhouse.	Cost of Farm Buildings.	Approximate Cost per Acre.
Acres.	£ £	£ £	£ *s.* £ *s.*
40	180 to 250	150 to 220	8 0 to 11 10
100	300 ,, 350	250 ,, 300	5 10 ,, 6 10
150	400 ,, 450	300 ,, 400	4 15 ,, 5 15
220	450 ,, 550	400 ,, 500	4 0 ,, 5 0
375	550 ,, 650	500 ,, 650	3 0 ,, 3 10
500	700 ,, 800	700 ,, 1000	3 0 ,, 3 15
650	800 ,, 1000	1000 ,, 1200	3 0 ,, 3 15

This is exclusive of cottages, of which one or more must be allowed for every 100 ac. of land, which is equal in the case of the larger farms to an addition of about £2 or £2, 10*s.* per acre.

In many cases the cost of buildings given in the above estimate might easily be exceeded. For instance, Mr. James Cobban of Haddo House Estate Office, Aberdeen, in a recent lecture on the history and construction of farm buildings, gave estimates of the cost of buildings in the north of Scotland on holdings of various sizes as follows:—For a holding of 5 ac.: dwelling-house containing kitchen, two bedrooms, scullery, and milk cellar, £133; steading: barn for straw and turnips, byre for one cow, one stirk, and one calf, £47; making a total of about £180, or £36 per acre. For a holding of 10 ac.: dwelling-house, containing kitchen, two bedrooms, scullery, and milk cellar, £133; steading, barn for straw, barn for two cows, two stirks, and two calves, and small place for turnips, £60; making a total of £193, or about £19 per acre.

For a holding of 20 ac., a dwelling-house containing a kitchen, two bedrooms, milk cellar, and scullery on the ground floor, and two bedrooms upstairs is usually required, and this may

cost £150. The farm accommodation would include barn, byre for nine or ten cattle, turnip shed, stable for two horses, cart-shed, &c., costing £150; making a total of £300, or £15 per acre.

For a 50-ac. holding, Mr. Cobban puts the average price of the dwelling-house at £210, and this would contain kitchen, parlour, bedroom, milk cellar, and scullery on the ground floor, with two bedrooms upstairs. The farm offices in this case consist of a barn, a byre for twenty cattle, turnip shed, stable for three horses, man's apartment, cart-shed, and small implement house. The average cost of this steading would be £304; making a total of £514, or about £10 per acre.

For a 100-ac. place, the cost of the dwelling-house may be put at £275, which would allow for a somewhat larger house than the foregoing, with perhaps an extra room. The farm buildings would provide for, say, 36 head of cattle, and cost about £480; making a total of £755, or about £7, 10*s*. per acre.

When we come to a 300-ac. farm, a good deal more money must be spent than is required for these smaller places. The dwelling-house, for instance, must be a substantial erection, with perhaps three sitting-rooms and a kitchen, and five or six bedrooms upstairs. A deal of latitude is possible here, but the cost may run up to £560. The steading would, of course, differ according to circumstances. In Mr. Cobban's estimate, accommodation is provided for 100 head of cattle and ample stabling, which would cost £1020. This would make a total of £1580, or about £5, 5*s*. per acre. On a 500-ac. farm the total cost would be proportionately increased to £2700, the rate per acre remaining about the same. These two latter figures, however, cover accommodation for a considerable head of stock, somewhat in excess, perhaps, of what is to be found on many farms of that size.

If we now apply these various estimates to the figures which are available of the distribution of farms according to size in Great Britain, it seems probable that the average capital invested in farmhouses and buildings, including cottages, on holdings of 5 ac. and above, is about £7 per acre.

But not only has a house and homestead to be provided, but allowance must be made for fencing, drainage, road-making, and water supply. According to a recent estimate (Trans. Surveyors' Inst., vol. xl, part viii) the cost of fencing, gates, and posts on a 20-ac. holding comes to £77, and on a 50-ac. holding to £154, while water supply, drainage, and road-making on the same area would absorb £53 and £75 respectively. The larger the area the smaller the proportionate cost, but drainage where it is carried out can seldom cost much less than £5 an acre.

Allowing for the fact that only a proportion of the total land in the country has required draining, we may perhaps put the average cost at £3, 10*s*. an acre. Fencing will probably add another 20*s*. to this estimate, while the expensive business of road-making, which costs £350 a mile, demands an allowance of 10*s*. per acre, so that without buildings the capital expenditure, taking the average of a number of farms of mixed sizes, can rarely come to much less than £5 an acre. On this general basis the following estimate of landlord's capital may be regarded as broadly applicable to ordinary farm holdings in Great Britain:—

Drainage and fencing	£4 10 0
Roads	0 10 0
Buildings, including cottages and water supply	7 0 0
Total	£12 0 0

A very interesting proof of the substantial accuracy of these figures is afforded by taking some particulars which are available of the actual cost incurred in converting some mixed forest land on the Crown estates into cultivated land. These figures were supplied by Mr. John Clutton in a paper read by him before the Surveyors' Institution, and are not estimates but actual results, obtained some years ago by the disafforestation of portions of the royal forests of Hainault in Essex, Whichwood in Oxford, Whittlebury in Northampton, and Delamere in Cheshire. The land was more or less heavily timbered, and the receipts from the sale of wood represented a substantial contribution towards the cost of the conversion, and also paid for the cost of public highways, legal expenses, and some fencing. The figures are as follows:—

	Hainault, 2255 ac.	Whichwood,[1] 3016 ac.	Whittlebury, 300 ac.	Delamere, 1554 ac.
	£	£	£	£
Clearing and grubbing	18,730	6,233	1,714	9,214
Marling	—	—	—	19,451
Draining...	22,618	520	1,602	1,417
Fencing[2]	—	1,506	220	1,397
Farm roads	1,123	811	—	894
Farm buildings and cottages	15,070	14,337	2,014	14,377
Miscellaneous ...	836	—	—	—
	58,377	23,407	5,550	46,750
Receipts from timber	55,000	14,080	5,800	17,815

The total cost of the conversion, therefore, was £134,084, towards which the timber contributed £92,695. The charges for felling, clearing, and grubbing the land, and also marling, may be put against the receipts for timber. The total area affected was about 6679 ac., and the sum expended was:—

		Per Acre.
Drainage and fencing ...	£29,280	£4 8 0
Farm buildings... ...	45,798	6 17 0
Roads and other expenses	3,664	0 11 0
	£78,742	£11 16 0

There were about thirteen farms and some small holdings. The farms were mostly arable, and varied a good deal in size. Only a little over one-third of the land required draining, while the cost of fencing was partly charged

[1] Part of this area was already cultivated and provided with buildings. [2] Included with draining.

against the timber. Owing to the character of the land, the cost of draining, however, so far as it was done, was above the average. The farms were well provided with buildings and cottages, and Mr. Clutton observes that the cost of building from various causes was somewhat high. The charge for roads, on the other hand, is low, as they are exclusively occupation roads, the expense of making public roads to serve the estates being put against the timber.

Here we have an actual example of the first cost of 'making' a number of farms in England, which is the more important because such cases but rarely occur, and it will be seen that the average is a trifle under £12 per acre. The cost at the present time would probably be a little less, but against this may be put the fact that the holdings were somewhat large in size.

Another estimate of the landlord's capital which may be quoted, was that made by Mr. Elias P. Squarey in the Journal of the Royal Agricultural Society for 1878. This includes four different kinds of farms, as follows:—

Cost of Buildings, Cottages, Water Supply, Drainage (where necessary), Roads and Fencing.

		Per Acre.
On a dairy farm of 200 ac., mostly pasture	£4050	£20 5 0
On a mixed arable and pasture farm of 500 ac.	5000	10 0 0
On a mixed upland, arable and pasture farm of 1000 ac. ...	7350	7 7 0
On a grazing farm of 300 ac. (without drainage)	2600	7 10 0

The mean of these estimates also lies somewhere between £11 and £12 per acre.

When the farm has been prepared for cultivation and equipped with the necessary buildings, the landlord is still called upon, year in and year out, to expend money in its maintenance, or, in other words, to protect his capital against undue deterioration, and to provide a sinking fund for its gradual replacement as the houses and buildings become worn out or need to be replaced by others more adapted to altered requirements. The main annual outlay is naturally on repairs, while heavy occasional outlay is required for new drainage, fencing, and gates, and for the restoration and rebuilding of houses and sheds, or the provision of new ones. It would be a difficult thing to make any estimate of the average outlay for these purposes, but statements referring to a number of large estates have been published by the Royal Commission on Agriculture, which show for a period of twenty years the actual expenditure on repairs and permanent improvements over an area of about 240,000 acres, as follows:—

Year.	Average Area Acres.	Cost of Repairs and Permanent Improvements per Annum.	Average Expenditure per Acre.
	£	£	s. d.
1872-76	240,000	96,404	8 0
1877-81	243,000	95,401	7 9
1882-86	239,000	89,227	7 6
1887-91	236,000	63,998	5 6

The average expenditure was 26 per cent of the gross rent, and this is exclusive of the cost of management, and miscellaneous expenses, which on an estate frequently run up to a considerable sum.

On the large estates of the Ecclesiastical Commission the repairs only fall in part on the Commission, but the cost on an area of 257,000 ac. amounted on the average to £62,400 per annum for the thirteen years (1880–92), or just about 5*s.* per acre, and on certain of the Crown Estates from 1888–93 there was an expenditure of £7500 per annum on 30,200 ac., which was somewhat less than 5*s.* per acre.

From this it would seem that the cost of the necessary repairs and improvements required to maintain a farm as a going concern probably average not less than 5*s.* per annum per acre. In addition, interest must be regarded as chargeable on the capital, which, at say $3\frac{1}{2}$ per cent on £12, would amount to 8*s.* 5*d.* per annum. It will, of course, be understood that in speaking of the capital invested in the land, reference is made solely to the average sum which the provision of drainage, fencing, gates, roads, and buildings would cost to supply. The capital invested in land when purchasing it represents all this, and also a payment for the 'economic rent' which it may be expected to produce, as well as in many cases a payment for amenities appertaining to its possession. [R. J. T.]

Capital, Tenant's.—Capital is the stock-in-trade—the wealth necessary for carrying on a business, without which, or by the diminution of which, it must either be relinquished or curtailed. To live on capital means entering upon a downward course, while, on the other hand, as long as the capital remains intact, no serious loss can accrue to its possessor. Revenue is the legitimate offspring of capital, and the two must always be viewed separately in any statement as to the financial soundness of a business. It is true that capital may be increased out of revenue, but this only means an apportionment of profits towards the extension of the business, or for purposes of keeping up the capital value of the existing plant. Capital is perishable, and in many cases eminently so. Take, for example, the implements, the food, or the horses employed on a farm. They all either wear out or are consumed. So also the engines, rolling stock, and permanent way of a railway. The more energetic the management the more rapidly do they deteriorate, so that capital (although fixed, or increasing, in value) necessarily wastes, or may be said to be in a state of flux. To attempt to preserve capital by limiting its use is contrary to good business traditions, and probably the most profitable businesses are accompanied with a constant replacement of capital. Capital does not only exist in the form of plant, or appliances for carrying on the business, but also in many invisible and intangible forms, some of which are extremely sensitive, and wither away on the least breath of panic. This view of capital bears upon socialistic ideas of seizing upon capital for the common good. Much of it would inevitably elude the grasp. The value of capital depends upon the revenue

which it is capable of producing, and revenue again depends upon skill, reputation, personal energy, and other qualities, without which the capital value of a business would be reduced to a break-up price. This is eminently true of manufactures which are made profitable by agencies that cannot be valued on a monetary scale.

In agriculture, the live and dead stock which stand as the farmer's capital are, it is true, always saleable at current prices. Still, there is a value in farming capital of a similar character to the above, whenever reputation has been achieved; and it is clear that live stock, for example, which may be worth hundreds of pounds per unit in the hands of the breeder, sensibly deteriorates in value as soon as it passes into the hands of those who have not the connection for disposing of it, or the skill for maintaining its condition, or for transmitting its properties to its descendants. Farming capital in many cases owes its value to its possessor, and a 100-guinea bull, bought from a noted herd, cannot be valued at anything like the same amount after it finds its way into an ordinary stock of dairy cows. Other instances of a similar nature might be given, in order to show that capital value depends upon the revenue which it is able to yield, under certain circumstances.

In dealing with farming capital it is the object of the writer to treat only of that required for the occupation of the land. The soil, the buildings, the roads, and fences, &c., are the property of the landlord, and have sometimes been termed fixed capital. Still, it must be allowed that many portions of the tenant's capital may be properly termed 'fixed', while others are of a fluctuating character, and some items are of a doubtful nature as to whether they are to be considered as capital, or as the result of processes of capital. The grain grown upon the farm is part of the revenue of the farmer, as much so as the milk yielded by his cows, or the wool and lambs produced by his flock. They represent capital without being capital; otherwise their sale would diminish the farmer's stock-in-trade, which is not true. The labour, food, manures, and other outlays, such as rent, required for the full development of the produce, are capital. So also are the flocks or herds required for the breeding of young stock. The man who sells his lambs in the autumn does not infringe upon his capital, but he who lowers his stock of cows or of ewes undoubtedly does so.

The most practical way of deciding as to what is capital and what is revenue, is to ask what items are necessary for carrying on and keeping up the value of the stock of the farm? This question is best answered by considering the outlay, under various headings, necessary for entering upon a holding and for carrying on the work of the farm until the stage of fruition is reached. It also should include sufficient money for maintaining the farmer and his family, and for the payment of rent, rates, and trade bills. It should also provide for labour, both horse and manual, purchased food, manures, and seed, as well as for other items almost too numerous to specify, necessary for the growth of live stock and the securing and marketing of crops. That there should be a reserve fund for losses among stock, or on account of disappointments with regard to crops, is equally evident, and when all these items are considered it will be seen that the amount of capital must be considerable.

The question of capital is further complicated by the fact that a farm begins to throw in money almost immediately it is entered upon. There will be dairy produce, eggs, or young pigs for sale, and long before the first year has expired there will be wool, lambs, calves, and a secured crop of corn. These sales during the first year of tenancy ought to be deducted from the total sum expended, before a just estimate can be arrived at as to the actual capital invested, and this is the plan on which it is now intended to proceed.

The valuation of standing crops, tillages, tenant's fixtures, unexhausted residues of manures, feedingstuffs, &c., are included in the capital sum, but the amounts realized, either immediately after entry, or during the first year, will be deducted as already explained. The claims of the outgoing tenant for labour, and for any expenditure which will benefit his successor, are essentially capital, and will always appear to the credit of the tenant whether he remains or quits. The valuation need not necessarily include the corn crops, but as a matter of convenience it is as well to take them over and pay for them over an extended period of say three, six, or nine months.

Time of Entry.—The amount of actual capital required at Lady Day is less than at Michaelmas. The first half-year's rent in a Lady Day entry is, for example, paid out of farm produce instead of out of capital, and the period between entry and fruition is abridged. The tillages are heavier, it is true, as they include the labour, seed, and sowing of wheat and spring corn. The two terms vary considerably, but for our present purpose we prefer to take a Michaelmas entry.

The various headings which form the capital sum may be summarized as follows:—

(*a*) Payments to outgoing tenant.
(*b*) Horses and live stock.
(*c*) Implements, including harness and tools.
(*d*) Seed.
(*e*) Manures purchased.
(*f*) Foods purchased.
(*g*) Trade bills and unavoidable expenses.
(*h*) Rent, rates, and taxes.
(*i*) Labour.
(*j*) Maintenance.

The first nine items must be regarded as capital expenditure, but the last may be left out of calculation, as it is not always necessary. If, for instance, the tenant is already established, and merely takes on an additional farm, he will not include maintenance in his calculations. It, however, deserves mention, as a new beginner must set up house and live for some months out of his means, and possibly out of his capital. We shall now proceed to give an approximate idea as to the amount required for each section, and in order to do this it is necessary to fix upon a definite area, style of farming, proportion of arable land, and character of the soil. Five hundred acres, 400 of which is arable

land and 100 ac. permanent pasture, all of fair quality, and capable of being ploughed with two horses, has always been a favourite example. It is large enough for the employment of expensive implements, and may be doubled without interfering with the general scale in respect of outlay. A larger proportion of grass would be an improvement, but any calculation may be corrected according to the varying proportion of grass and arable land. So far as the amount of capital required per acre is concerned, it is doubtful whether grass or arable land requires the more money for stocking, as so much depends upon the character and quality of the live stock purchased.

Payments to Outgoing Tenant. — *Tillages.* — These include all the cultivations and dressings required for carrying on the farm up to the date of the transfer. If, for convenience, the arable land is supposed to be cultivated on a four-course principle, the tillages will come under the following heads, and the remaining payments to the outgoer may be represented by figures of an approximate but reasonable amount:—

	£	s.	d.	£	s.	d.
100 ac. of young seeds, and sowing of the same at 13*s.* per acre	65	0	0			
100 ,, untouched stubbles	0	0	0			
100 ,, growing roots, tillages, valued at £3, 10*s.* per acre	350	0	0			
60 ,, old seeds already dunged for wheat, at 10*s.* per acre	30	0	0			
40 ,, seeds untouched	0	0	0			
400 ac.	445	0	0			
200 ac. of straw, at 14*s.* per acre	140	0	0			
100 ,, clover hay, at £4 per acre	400	0	0			
20 ,, old field hay, at £4 per acre	80	0	0			
Compensation allowed for purchased food expended during last two years	150	0	0			
,, ,, ,, liming, chalking, &c., during recent years	50	0	0			
Sundry tenant's fixtures taken over	35	0	0			
Total amount paid to outgoing tenant				1300	0	0
Equipment.						
Horses—12 horses (6 two-horse teams) at £35	420	0	0			
1 odd horse	30	0	0			
1 nag horse	25	0	0			
Live Stock—400 ewes at 50*s.*	1000	0	0			
60 cows at £17	1020	0	0			
1 bull	40	0	0			
1 young bull	20	0	0			
4 brood sows at £3	12	0	0			
Poultry	25	0	0			
Total live stock				2592	0	0
Implements as per list				1356	10	0
Current Expenses during First Year.						
Seed for 100 ac. of wheat, at 12*s.* per acre	60	0	0			
,, 100 ,, spring corn, at 12*s.* per acre	60	0	0			
,, 100 ,, clover, at 12*s.* per acre	60	0	0			
,, 20 ,, vetches, at 15*s.* per acre	15	0	0			
,, 20 ,, rye, &c., at 12*s.* per acre	12	0	0			
,, 10 ,, mangel, at 3*s.* 6*d.* per acre	1	15	0			
,, 80 ,, roots, at 2*s.* per acre	8	0	0			
Sets for 10 ,, potatoes, at £3 per acre	30	0	0			
Total seed and sets				246	15	0
Manures purchased for—						
90 ac. of roots (superphosphate), at 10*s.* per acre	45	0	0			
10 ,, potatoes, at £1, 5*s.* per acre	12	10	0			
Foods purchased (cake, &c.)	300	0	0			
Total foods and manure				357	10	0
Trade bills, including:—Coal, £15; oil, £4; machine oil, £4; sheep dip, £3; blacksmith, £32; veterinary surgeon, £5; insurance, £20; timber, £10; beer (occasional), £3; wheat-dressing, £1; market expense, £6; commission, stamps, &c., £5; garden seeds, £3; castrating, £3; unforeseen, £10				124	0	0
Rent, £1 per acre; rates and taxes, 5*s.* per acre over 500 acres				625	0	0
Labour taken at 27*s.* 6*d.* per acre over 500 acres				687	10	0

Summary.

	£	s.	d.	£	s.	d.
Payments to outgoing tenant	1300	0	0			
Horses, sheep, cattle, pigs, and poultry	2592	0	0			
Implements	1356	10	0			
				5248	10	0
Seed and sets during first year	246	15	0			
Manures and foods purchased	357	10	0			
Trade bills	124	0	0			
Rent, rates, and taxes	625	0	0			
Labour during first year	687	10	0			
				2040	15	0
Total expenditure during the first year				7289	5	0

Implements.—In estimating the cost of implements, the most approved method is to assume them to be purchased new. Second-hand implements may be picked up cheap, but the amount of depreciation and repair is then a serious, but incalculable, amount. It is not necessary in these days to purchase a threshing machine and portable engine, as they can be hired. In the case of fixed machinery and engine, they are not part of the tenant's capital, but they are nevertheless included in the following schedules.

The following implements are necessary, and care has been taken to keep the list within bounds. The number of teams regulates that of tillage implements, and if we assume single ploughs, six will be required. Double-furrow ploughs would naturally alter this particular item.

List of Implements, with Approximate Prices, for a Farm containing 400 ac. Arable and 100 ac. of Pasture and Meadow

	£	s.	d.
Tillage Implements—			
6 ploughs at £4	24	0	0
2 sets of heavy harrows at £5	10	0	0
3 ,, seed harrows at £4, 10s.	13	10	0
2 ,, chain harrows at £4, 10s.	9	0	0
1 spring-tooth or other good cultivator	12	0	0
1 ring roller, 20 in. diameter	12	0	0
1 four-horse plain roller, four-cylinder, 20 in.	14	0	0
1 two-horse roller	8	0	0
1 light wood roller	3	10	0
1 potato and double mouldboard plough	4	10	0
Sowing and Hoeing Implements—			
1 corn drill	28	0	0
1 root drill, fitted for sowing superphosphate dry	28	0	0
1 broadcast sowing machine	12	0	0
2 grass seed barrows at £3, 15s.	7	10	0
2 horse hoes at £7	14	0	0
2 single-horse scufflers at 50s.	5	0	0
Securing Crops—			
2 self-binders or harvesters at £35	70	0	0
2 grass cutters at £18	36	0	0
2 horse rakes at £12	24	0	0
6 wagons at £30	180	0	0
6 carts at £12	72	0	0
2 water carts at £15	30	0	0
Preparing Crops for Market—			
1 threshing machine	125	0	0
1 eight-horse-power portable engine	240	0	0
1 elevator or stacker	40	0	0
2 winnowing machines, £8 and £12	20	0	0
1 barley screen	10	0	0
1 weighing machine and weights	2	10	0
50 sacks at 1s.	2	10	0
Live Stock—			
2 sheep turnip cutters at £5	10	0	0
1 Bentall pulper	3	10	0
1 power chaff cutter	40	0	0
1 power oil-cake breaker	12	0	0
1 power grist mill	20	0	0
Dairy utensils estimated at £50	50	0	0
Harness estimated as 12 sets at £4	48	0	0
Sheep troughs and hurdles	30	0	0
Shepherd's house on wheels	30	0	0
Tools—Including spades, shovels, forks, scythes, prongs, crowbars, barn shovels, bushel measures, ropes, cow chains, head-stalls, sieves, besoms, brushes, combs, buckets, rakes, hay knives, muck scrapers, hoes, pickaxe, mattock, barrows, sack barrows, ladders, bull stick, drenching horn, &c.	56	0	0
	1356	10	0

The above list is not excessive, and might have been lengthened by the addition of many instruments now recommended, such as steaming apparatus, weighbridge, swath turner, hay tedder, &c. The implements named could scarcely in any case be dispensed with, and hence the sum of £1356, 10s. is put down against implements, not as exactly representing the sum required, but rather as showing how this considerable sum may be accounted for.

We have now arrived at a figure including all the items for which outlay is required during the first year, namely, £7289, 5s., and we shall next endeavour to ascertain to what extent it actually represents capital.

Sums in Reduction of Gross Expenditure re-

ceived during the First Year.—The following receipts will be available as a set-off against the above inevitable outlay:—

	£	s.	d.
Wool from 380 ewes at 5s. per fleece ...	94	0	0
Proceeds of sale of 100 draft ewes at 45s....	225	0	0
,, ,, 100 lambs at 45s. ...	225	0	0
,, ,, 100 ,, 38s. ...	190	0	0
,, ,, 100 ,, 32s. ...	160	0	0
[The remaining lambs go into flock.]			
Produce of 50 cows at £16 each	800	0	0
,, 4 breeding sows	20	0	0
,, poultry	50	0	0
,, 10 ac. of potatoes	200	0	0
,, 100 ,, wheat at £7 per acre (less seed)	640	0	0
,, 100 ,, spring corn at £6 (less seed and horse corn)	430	0	0
	3034	0	0

Depreciation of Capital during the Year.—Although there need be no actual depreciation, there must have been replacements of cows and horses, wear and tear of implements, and other losses, which must be replaced, and these are usually represented by 10 per cent on the original value. They must be made good, and the following sums are set aside for the purpose:—

	£	s.	d.
Depreciation upon £415 of horse stock at 10 per cent	41	10	0
,, £1020 of cow stock at 10 per cent	102	0	0
,, £1356 of implements at 10 per cent	135	10	0
	279	0	0

There should be no deterioration in sheep (replaced out of lambs), tillages, hay, or straw, and these items will stand at their original value at the end of the first year.

Summary

The net capital, irrespective of cost of living or maintenance of the farmer, will be represented by the following statement: Capital spent on claims of outgoing tenant, live stock, implements, and depreciation of stock, *plus* the current expenses of the first year, *minus* the proceeds of the first year. Applying this formula to the case in point, we find—

	£	s.	d.
Capital expenditure at outset	5248	10	0
Expenses during the first year	2040	15	0
	7289	5	0
Depreciation of stock during the first year	279	0	0
	7568	5	0
Less proceeds from the farm during the first year	3034	0	0
Net expenses representing the capital	4534	5	0

Farmer's Maintenance.—If £466, 15s. is allowed for maintenance, we arrive at the traditional £10 per acre supposed to represent the capital required for entering upon a farm; but this must be allowed to be a meagre estimate, leaving the occupier exposed to the risks of bad seasons and diseases among live stock. For a man to invest his whole capital in an occupation of 500 ac. of land would seem scarcely wise, and hence some reserve of capital and some independent sources of income appear to be necessary.

The above is a fair representation of what may be expended upon such a farm as has been taken for an example, but it is evident that high-class horses, cattle, and sheep, and an equipment comprising novel appliances, might easily absorb double the amount arrived at.

The Variations in Amount of Capital.—It is evident that the amount of capital must vary enormously with the nature of the farm. There is no comparison between stocking a Highland sheep run, where the number of acres per sheep is the unit, and a farm in which the number of sheep per acre is to be considered. Again, the above calculations would be entirely inadequate on farms where hops, fruit, and market-gardening are interspersed with corn and ordinary live stock. It would be impossible within our prescribed limits to give cases of farms of various character; but with the above outline before him, any enquirer can fill in the items upon the same general principle. He must provide for a settlement with the outgoer, for the purchase of live and dead stock, for seeding and manuring his land, maintaining his animals and paying his labourers for one year; and he may deduct his returns during the same period, as a set-off, in relief of the sum needed.

Capital in Comparison with Revenue.—One of the most obvious facts in farming is the smallness of the revenue in comparison with the capital invested. In most businesses the 'turnover' is many times greater than the capital. If we take merchants, dealers, or shopkeepers as examples, a few hundreds expended upon goods or chattels in order to start business may result in a yearly turnover of many thousands. Most businesses would be declared to be grossly over-capitalled if the yearly revenue did not several times exceed the amount invested; but in farming the yearly revenue falls far short of it. The reason of this great difference is that the genuine farmer produces a crop only once a year, whereas the dealer may turn over his capital as many times as he wishes or can negotiate sales for. He may lose on one transaction and gain on others, and is bent upon increasing his connection. The farmer (unless also a dealer) must await seasons, and cannot hasten the maturation of either his crops or his live stock. His gross profits should be large, although his *net* profits may be small. He obtains his increase through natural causes, and his goods *grow* into money under his guidance. His success depends upon whether the price he can obtain for his produce is in excess of the costs of production. His total produce is limited by the productiveness of his land and the fecundity of his stock; and the result is that while £10 per acre may be invested in his business, he cannot expect £10 per acre gross return off his land. On few farms does it exceed £6 or £7 per acre over the entire area. Still, the profits need not be smaller than in other pursuits, for it is evident that if the farmer can keep his

expenses £1 per acre below the value of his produce he nets £500 a year off 500 ac., and receives 10 per cent on a capital of £5000. That this result is realized in many cases there is no room to doubt, for it is usually thought that if a farm is not over-rented, a sum equivalent to the rent should be retained by the farmer as profit.

Other Methods of Computing Capital.—A certain number of rents is sometimes used as affording an idea as to capital required. In a poor clay-land district in the North of England it used to be thought that a sum equivalent to three rents should enable a man to take a farm. In a southern district, where turnip cultivation and sheep make greater demands upon the pocket, a capital equal to five rents is thought to render a candidate eligible. In the first case, where a three-field course of cropping was at the time referred to in vogue, one-third of the arable land was in bare fallow and two-thirds in saleable corn and beans—while the demands of the grass land were small. In the second case, turnip husbandry, a good-sized flock of sheep, and a large dairy of cows would need much more capital. The five-rent idea is variously stated, as for example:—

One rent for the landlord.
One rent for the tenant.
One rent for labour.
One rent for horse maintenance, foods, and manures.
One rent for seed and incidentals.

This statement is more neat than accurate, but the writer has often heard it enumerated.

The largest capital in ordinary farming is needed under a four- or five-course system, in which catch-crops precede roots; while a heavy stock of both sheep and cows is maintained, and purchased foods are freely used. In such cases £10 per acre is readily absorbed. If the occupier breeds high-class stock there seems to be scarcely a limit to the amount of capital which may be invested, and in such cases the horses and cattle may be worth hundreds of pounds each, and breeding sheep and pigs may far transcend ordinary market price. It would not assist us much to enter upon such cases, which are, however, not uncommon. The writer was privileged to visit a farmer of 3000 ac. in Cambridgeshire, who informed him that he estimated his capital in the sum of £36,000, or £12 per acre.

Importance of Sufficient Capital.—It is better to farm a smaller area with ample capital than the reverse. In order to farm successfully, a man's means ought to be more than his capital, otherwise he cannot stand reverses. He should be able to employ the best implements, to maintain good stock in good condition, and to cultivate his land thoroughly. He should be able to purchase the best seed and use the best male animals; and these objects cannot be achieved on a farm beyond the financial capacity of the occupier.

Stability of Farming Capital.—One feature in farming capital is that it is always realizable, and another is that it may be looked upon as safe. As long as the farming stock is kept up to the mark, it can always be disposed of at market price. In this respect farming is superior to many other ventures. The farmer's commodities are necessaries of life, and are not affected by changes of fashion nor superseded by new inventions. As to the profits from farming capital, all that can be said is that they are moderate even in successful cases; but if we take the established farmers of the country, many of whom belong to families who have followed the same occupation for generations, there does not appear to be much cause for complaint.

Advantages of the Farmer's Position.—Although farming profits are small (for 10 per cent is undoubtedly a sanguine estimate), there are many advantages which appeal to the true lovers of the pursuit. These considerations have an important bearing upon the question of interest upon capital, or they would not be appropriately introduced in this connection. First, then, the farmer includes his house rent, garden, stable, and horse keep in his business expenses. Secondly, he is free from urban rates, although he may complain of being, on the whole, heavily rated. Thirdly, he enjoys a great deal of leisure, and his business is one which he need not relinquish with advancing age. It is, in fact, an occupation to which countless men in other businesses look forward as an agreeable form of retirement. Fourthly, the farmer is often a sportsman, and can indulge in shooting, fishing, coursing, and even in hunting. Such an occupation does not call for large profits, but if the amenities were capable of being valued in terms of money, even 5 per cent as a fair interest on the capital expended might seem satisfactory. [J. WR.]

SCOTCH HILL FARM.—In estimating the amount of capital required we may take as an example a typical hill farm carrying and keeping up a regular stock of 40 score of blackface ewes on fairly good hill pasture. We assume that plenty of meadow hay can be grown for sheep-feeding during a severe winter, and that there is sufficient arable land to give a yearly 'break' of 5 ac. or so, if wrought on a seven-course shift. The annual rental, including rates and taxes, is put at £300. The following would be the actual stocking and its approximate value at the time of entry (Martinmas term):—

Live Stock

(*a*) SHEEP (taken over at valuation)

30 score of ewes, 2nd, 3rd, and 4th crop, at 30*s*. each	£900	0	0
12 score of gimmers at 27*s*. 6*d*.	330	0	0
12½ score of ewe hoggets at 20*s*.	250	0	0
20 rams (various ages) at 80*s*.	80	0	0
Total	£1560	0	0

In the above prices, however, no account has been taken of what is known as 'acclimatization value'. Now, a sheep stock is of considerably more value on its own pastures than in any open market. Consequently, to cover this

acclimatization value, we must make a further allowance of, at least, 6*s.* per head (£6 per score). The capital invested in sheep stock now stands as follows:—

Actual market value...	£1560	0	0
Acclimatization value	333	0	0
Total...	£1893	0	0

On such a farm as the one under consideration the initial outlay in the sheep stock always accounts for the greater part of the capital invested.

(*b*) Cattle

Four cows at £14, 10*s.*	£58	0	0
One young bull at £10	10	0	0
Four young queys at £6	24	0	0
Total...	£92	0	0

More cows may be kept, but these are sufficient to supply all the milk and butter required, as well as make special provision for the lambing season. As a general rule, few young cattle are reared on the blackface hill farm.

(*c*) Horses

One heavy work horse	£36	0	0
One strong pony	30	0	0
Total	£66	0	0

The pony must be capable of taking the side of the plough, reaper, &c., when required, otherwise it would be necessary to keep a third horse, and there is not sufficient arable land to warrant this.

(*d*) Allowance for pigs and poultry, £10 0 0

So far we have considered only the live stock, but there are various other items which necessitate further outlay. The most important are considered below.

Tenant's fixtures, including sheep-dipping tank	£16	0	0
Part of former crop—oats, hay, straw, turnips, &c.—taken over from the previous tenant	60	0	0
Implements: ploughs, harrows, reaping and mowing machines, &c., barn, byre, and dairy utensils, tools, &c.	120	0	0

No very expensive implements would be purchased where the area of arable land is so limited, and a large number of those necessary are considered as second-hand purchases. In this way the outlay on implements can be reduced considerably from what would be the case if everything was purchased new.

Manures and extra feedingstuffs	£40	0	0
Allowance for spring seeding of oats, grasses and clovers, turnips, and potatoes	12	10	0
Sheep dip, tar, lambing oils, &c.	25	0	0

Labour

On a hill farm the labour bill is never so great as on an arable farm. The following, with a little extra help in clipping, hay, and harvest time, would be quite sufficient:—

One experienced shepherd	£45	0	0
One young shepherd	40	0	0
One ploughman and general odd man	40	0	0
	£125	0	0
Allowance for market expenses, trade bills, and other miscellaneous expenses	£50	0	0
Rent, rates, and taxes	300	0	0

Summary

Live stock—(*a*) Sheep	£1893	0	0
(*b*) Cattle	92	0	0
(*c*) Horses	66	0	0
(*d*) Pigs and poultry	10	0	0
Tenant's fixtures, including dipping tank	16	0	0
Part of previous crop taken over	60	0	0
Implements, tools, &c.	120	0	0
Manures and feedingstuffs	40	0	0
Spring seeding of oats, grasses and clovers, turnips, and potatoes	12	10	0
Sheep dip, tar, &c.	25	0	0
Labour	125	0	0
Market expenses, trade bill, and miscellaneous expenses	50	0	0
Rent, rates, and taxes	300	0	0
	£2809	10	0

This sum (£2809, 10*s.*) represents the actual amount of capital, exclusive of maintenance, necessary for renting, stocking, and working the hill farm under consideration for the first year. There would be practically no receipts available before the end of August except the wool, which might be, and often is, sold in July. By the end of the first year, however, the following receipts could be relied on:—

Wool sales after allowing for an average death-rate, 1060 fleeces at 2*s.* 6*d.*	£132	10	0
400 wether lambs at 14*s.*	280	0	0
150 ewe lambs (seconds) at 12*s.* 6*d.*	93	15	0
[The other ewe lambs go into the flock to keep up the stock.]			
190 cast ewes at 21*s.*	199	10	0
Profit from pigs, poultry, and surplus produce of the dairy cows	20	0	0
	£725	15	0

The value of the hay, oat, and turnip crop might also be taken into account, but as the most of it, if not all of it, would be required for feeding, it is unnecessary to consider it further.

[W. G. R. P.]

Market Gardens.—The amount of capital required to stock a market garden will vary very considerably, according to locality and class of produce grown. The rent paid for good land will amount to anything between £3 and £30 per acre, even higher sums being paid for what may be termed 'accommodation land', in close proximity to a good market, and of reputed quality as regards the depth to which the soil has been trenched and enriched with manures. It need scarcely be remarked that much of the success attending market gardening will depend on the practical experience and enterprise of the proprietor. No calling requires so much supervision, forethought, and attention to detail as does the cultivation of miscellaneous crops for the open market, and doubtless the failure to make market gardening and fruit-growing re-

munerative is very largely traceable to a want of practical experience, and also of a business training, on the part of the individual who has invested his capital in this enterprise. It is impossible to definitely state what particular crop is likely to give the best return. Thus the market gardener must exercise his own judgment as to which crops are most likely to meet a brisk demand at prices sufficiently high to ensure their being produced at a profit to both grower and retailer.

In estimating the amount of capital required to establish a market garden it is advisable to take a given area, say of 20 ac., and assume that it will be laid out as a mixed plantation, to contain fruit, flowers, and vegetables, in the following proportions: 15 ac. fruit, 4 ac. vegetables, and 1 ac. flowers.

Those who are familiar with the management of market gardens know that it is impossible to lay down definite areas with the intention that no other form of vegetation other than that for which they were originally intended shall be permitted within their respective boundaries; thus some allowance must be made for rotation and intercropping from time to time. Taking for granted that new ground is acquired, and that there is no stock to work upon, it will be well to plant those varieties and forms of apples and other hardy fruits which are capable of giving quick returns, therefore 8 ac. may be planted with bush apples on the Paradise stock, 12′ × 12′ = 302 × 8 = 2416 trees, and intercropped with the following 4 ac. strawberries: 3′ × 2′ = 6958 × 4 = 27,832 plants; 2 ac. miscellaneous flowers, 1 ac. tomatoes, 1 ac. vegetables. The strawberries can be intercropped with Lisbon onions, winter lettuce, or early cabbage, &c., for the first year. Half an acre will suffice for bush pears on the quince stock, 12′ × 12′ = 150 trees, and may be intercropped with gooseberries, 6′ × 6′ = 450 plants.

If the district is favourable to the growth of plums, 6 ac. should be placed at their disposal, planting half standards 15′ × 15′ = 193 × 6 = 1158 trees, intercropped as follows:—

1½ ac. red currants,	5′ × 5′	= 2323	plants.
1½ ac. black ,,	5′ × 5′	= 2323	,,
1½ ac. raspberries,	3′ × 5′	= 4061	,,
1½ ac. gooseberries,	5′ × 5′	= 2323	,,

The above-mentioned bush fruits to be intercropped with flowers or vegetables, whichever are found most remunerative. The remaining half an acre of fruit ground may be planted with Loganberries, 7′ × 8′ = 388 plants, and intercropped with vegetables.

There now remain 4 ac. for vegetables and 1 ac. for flowers, but there is no reason why a portion of these 5 ac. should not be set apart as nursery ground for the propagation of fruit trees and bush fruits.

Where intensive cultivation is practised, and particularly where floriculture is largely indulged in, it is impossible to arrive at a fair estimate of labour per acre for the year; but in a mixed plantation such as described, the estimated capital per acre, exclusive of rent and labour, is approximately £30. According to the above plan of cropping, the capital would be expended thus:—

Bush apples, 2 years, on broad-leaved Paradise, 2416 at 1s.	£120	16	0
Bush pears, 2 years, on quince, 150 at 1s....	7	10	0
Half standard plums, 1158 at 1s.	57	18	0
Loganberry tips, 388 at 5d.	8	1	8
Gooseberries, 2¾ at £3	8	5	0
Red currants, 2⅓ at £3	7	0	0
Black currants, 2⅓ at £3	7	0	0
Raspberries, 4$\frac{1}{10}$ at 35s.	7	3	6
Strawberries, 28 at 4s.	5	12	0
Flower, vegetable roots, and bulbs	50	0	0
Vegetable and flower seeds	15	0	0
Suitable horse, light dray, and harness ...	55	0	0
Spraying machine	15	0	0
Plough, cultivator, harrow, and sundry tools	15	0	0
Manures for first year	50	0	0
Frames, marrow glasses, tomato pots, stakes, &c.	30	0	0
	£459	6	2

To this total must be added rent, rates, and petty cash expenses, including wages.

The plan upon which most growers work is to make the intercrops pay the working expenses, and to grow on the fruit trees, which yearly increase in value. This can always be done when the land is suitable, and free from troublesome weeds, as couch, convolvulus, docks, thistles, and such like, and when not too heavy pioneer, extension, or supply expenses have to be borne. This arrangement leaves the fruit returns to provide rent, taxes, interest on capital, and profit, strawberries being regarded as an intercrop. It is not unusual for crops such as sea kale to give returns, after paying carriage and salesmen's commission, at the rate of £40 per acre; mint, £40; spinach, £50; cabbage, £30; wallflowers, £30; violets, £50; vegetable marrows, £50; tomatoes, £50. Tomatoes in a bad year may only just pay expenses, whereas in a good season as much as £75 per acre is sometimes realized. However successfully crops are grown, much will depend on the manner in which they are packed and placed on the market. The estimate for manure has been kept as low as is practicable for the first year; it is found that intercrops require liberal manuring if good results are to be expected. Whether natural or chemical manures are employed they should always be of the best, and it will be found more economical to mix one's own manures in preference to experimenting with the many compound manures now on the market. [J. C. N.]

Capital invested in Woodlands. See WOODLANDS.

Capon.—This term is generally used to designate large cockerels marketed in the autumn and winter months. In France and America the best specimens have been caponized, by which is meant that the testicles are removed when the birds are eight to ten weeks old; but in Britain the great majority of dead birds sold as capons have not been operated upon in this way. The process is by no means difficult, but is not easy to describe, and should be learnt from an expert, otherwise there is almost certain to result considerable suffering to the bird;

and for its success special instruments are required. The object of caponizing is to check the development of sex characters, to prolong the period of growth and thus to secure greater size, to retain the softness of meat found during chickenhood, but which is largely lost with increasing age, and by making more gentle the nature to lead to a greater tendency to flesh production than would otherwise be the case. Capons fatten readily when seven to ten months old, and frequently attain a great size, as we have seen specimens weighing nearly 12 lb. each, yet beautifully soft and tender in flesh. It should be noted that only those birds which are intended to be kept to the ages named above should be caponized, as not only is it unnecessary for chickens that are to be killed when three months old, but they would be less fleshy at that age than those not subjected to the operation. [E. B.]

Capped Elbow.—An unsightly enlargement on the point of the elbow is by custom

Capped Elbow

called a capped elbow, as a similar deformity of the hock is called a capped hock. It may be soft to the touch and containing a sanguineous or a straw-coloured fluid, or if of long duration have become solidified. It is commonly attributed to bruising by the heel of the shoe, and in America is spoken of as a shoe boil. Lying on bare floors, or bruising in lying down, or slipping in rising from the ground, may equally well cause it. A severe bruise, such as might be contracted by a slip in rising from the ground, is followed by rapid swelling, heat, tenderness, and distension with serous fluid. When due to oft-repeated pressure of the shoe or bad bedding, the growth is slow, but continuous and less sensitive, and is more in the nature of a callus. Capped elbows often remain in this condition for a long time, making no increase, but an extra pressure from a long shoe or a bruise from other cause will result in the formation of an abscess. Lameness is seldom caused, but the tumour sometimes attains to a great size, and is extremely unsightly. *Treatment.*—If recent and not severe, a cooling dose or two of medicine, with frequent fomentation, and removal of the cause will restore the parts. If neglected or chronic, the sac will have to be evacuated by laying it boldly open with the lancet, and the secreting surface within destroyed by the injection of iodine. Old consolidated or callused tumours have to be dissected out, after which healing takes place and no great amount of blemish is left. [H. L.]

Capped Hock.—A swelling of the point of the hock which depreciates the value of a horse by its objectionable appearance is gener-

Capped Hock

ally known as a capped hock; but it is important to distinguish between that form of it which is due only to a simple effusion between the skin and tissues covering the point of the bone (*calcis*), and the more serious deformity caused by chronic inflammation of the synovial membrane between

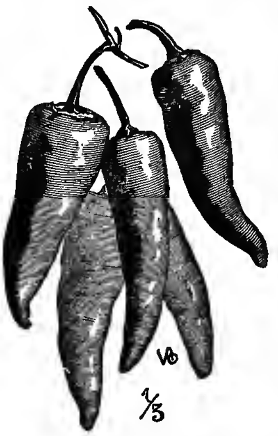
the tendon and the bone. On the point of the hock the tendon of the internal gastrocnemius muscle is expanded, and to prevent friction between it and the external one of the same name a synovial sac is interposed, whose office is to lubricate both surfaces and prevent friction. Injuries from without produce a depraved secretion, voluminous in quantity, and giving rise to the bulging of the skin at this part of the hock. The less serious is the more common form of capped hock, and is distinguished by appearing as a round tumefaction, and not as a fluctuating tumour bulging on each side of the tendons. The superficial swelling consists of bloodstained fluid and seldom occasions lameness. The second form, in which the synovial membrane is concerned, may be complicated by disease of the bone.

Treatment will be regulated according to the severity and duration of each case. Warm fomentations or cold affusions, followed by gentle massage with a dilute saponaceous liniment, will suffice to disperse simple bruisings; or large accumulations of fluid may be withdrawn by the aspirator. No puncture should be made in the synovial form of capped hock, but iodine dressings and gentle continuous pressure from a truss should be tried. Above all, the cause should be guarded against, lest a repetition of it should result in permanent hardening, incapable of removal by any process of absorption in our power to employ. While there is always a tendency to reduction of the volume by absorption of the fluid elements, there is also a disposition to form a permanent callosity. [H. L.]

Caprifoliaceæ. — This is the name for the nat. ord. of dicotyledonous plants which includes the well-known honeysuckles. The distinctive characters are: (1) The petals are grown together; (2) the ovary is placed on the outside of the flower; (3) the stamens adhere to the petals; (4) the ovary is chambered, usually becoming fleshy when ripe; (5) the plants are usually shrubs and always have opposite leaves. The important plants of this order are: Elder or Bourtree (*Sambucus nigra*), a shrub with compound pinnate leaves, regular flowers, and drupe fruits; Guelder rose (*Viburnum Opulus*), with simple three-lobed leaves and regular flowers; Honeysuckle (*Lonicera Periclymenum*), a twining shrub, with simple leaves and irregular flowers. Weigelia and Diervilla are favourite flowering shrubs, with dry, dehiscent fruits. [A. N. M'A.]

Capsella Bursa pastoris.—This is the botanical name of the weed commonly known as Shepherd's Purse. See SHEPHERD'S PURSE.

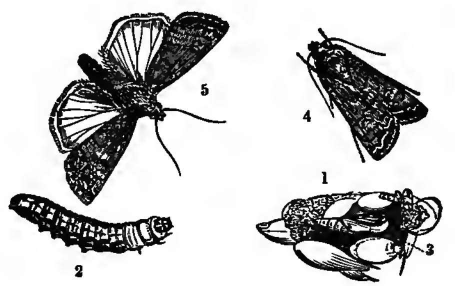
Capsicum, a genus of Solanaceæ, some of the species being grown for their fruits, which are used for pickles, or the seeds are ground into what are known as Cayenne and Chile peppers. Some of the kinds are grown for greenhouse decoration, the inflated fruits being coloured bright red or yellow. Plants are raised from seeds sown and treated as for celery. When the young plants are about 2 in. high they should be planted singly in 3-in. pots and grown on in warmth till the beginning of June, when if to be grown in the open they should be transferred to a sunny border. Generally, however, they do best in this country when grown in pots under glass. The fruits are ripe in September, when they may be gathered and dried, to be used for pickles, &c. The best sorts are Belle Pepper, Guinea Pepper, Purple Capsicum, and Spanish Mammoth. [W. W.]



Guinea Pepper (*Capsicum annuum*)

Carabidæ, a family of beetles, popularly called ground beetles. They are all very active, have long legs, and mostly feed both in the larval and adult stages on animal matter, but some are harmful to crops and fruit (see HARPALUS RUFICORNIS, STEROPUS MADIDUS). [F. V. T.]

Caradrina quadripunctata (the Pale-mottled Willow Moth) is the parent of a caterpillar which feeds upon wheat in the field, as well as after it is housed or stacked—sometimes effecting incredible mischief. Chickweed is also a common food plant. Where the moth lays her eggs is unknown. The caterpillars live through the winter, feeding upon the grain; and in February or March draw the corn together with a thin silken web (1 in fig.), in which they change to pupæ; in May, June, and July the moths hatch, and are often abundant in hayfields, rickyards, banks, and gardens.



Caradrina quadripunctata

The caterpillar (2 in fig.) is fleshy, and varies in colour from a dull ochreous red to a dirty green; the head is blackish, and on the first segment is a horny scale, with two brown spots; the abdominal segments have a wavy line on each side, edged with black, leaving a pale space down the back. The pupa (3 in fig.) is bright-brown, and shining. The moth is of a mouse colour, and rests with its wings closed flat upon the back (4 in fig.). The antennæ are thread-like: the body is rather slender: on the upper wings are three wavy transverse lines, terminating in three or four black spots on the pinion

margin, and there is an indistinct, kidney-shaped spot on the disk; at the base of the fringe is a line of black dots, and near this edge is a sinuous ochreous line, reddish and suffused on the inside: under wings pearly-white, with a slight tinge of brown next the fringe, and the nervures are also brownish (5 in fig.). They sometimes invade houses. [J. C.] [F. V. T.]

Caraway (genus Carum).—The fruits (commonly called seeds) of various species of Carum are carminatives, and yield valuable essential oils. The plants belong to the nat. ord. Umbelliferæ, and often exist as semi-cultivated or even wild plants. The following are the better known species: *C. Bulbocastanum*, the Black Caraway of Indian commerce; *C. Carui*, the true or white Caraway of Europe; and *C. copticum*, the *Ajwain* (or *ajowan*) of India.

Black Caraway exists as a wild plant on the Himalaya between 6000 and 11,000 ft. in altitude, but is also cultivated to some extent, though it is more frequently met with as a weed of cultivated lands. Indeed it often proves a source of danger to other crops owing to the fondness of wild pigs for its tuberous roots, which they dig up, to the great injury of the crops. From Bashahr and Kullu large quantities are conveyed to Amritsar, and from Kashmir to Lahore. Karachi obtains its supplies from Hazara and Baluchistan, while Cawnpore is supplied from Garhwal and Kumaon. Bombay, on the other hand, draws largely from Afghanistan and Persia. From these Indian emporia the supplies of the world are mainly derived.

The White or True Caraway is an annual or biennial frequently cultivated in northern and central Europe, and western Asia to the frontier of India. It is largely grown in Essex and Kent, also in Holland, Prussia, Northern Russia, and occasionally in Upper India. In England it has escaped from the fields and become a weed in many parts of the country. The seeds, like those of black caraway, are largely used in confectionery, as well as in flavouring spirits. A valuable essential oil is distilled from them which is extensively employed in perfuming soaps, as also in certain medicines. The odour-bearing principle known as *carvone* possesses all the properties of the pure drug, and the second product, *carvene* or *limonene*, is a by-product employed for the inferior purposes of caraway. The Bavarian wild plant yields the highest percentage of oil (6·5), while the Russian affords the lowest (3·2). The seeds from which the oil has been abstracted are dried and pressed as cattle food, being prized because of the high percentage of crude protein (20 to 23) and of fat (14 to 16) which the cake contains.

The Ajwain is a herbaceous plant cultivated throughout Bengal and many other parts of India, also in Afghanistan, Persia, Egypt, and more recently Europe. The aromatic fruits (seeds) are in much request in India as an ingredient in curry stuffs and a spice employed in *pan*. From them are prepared by distillation both a water and an oil. Omum water is manufactured and sold in most Indian bazaars, and a stearoptene known as *Ajwain-ka-phul* (flowers of *ajowan*) separates from the oil. This is identical with *thymol*, the constituent of the oil (45 to 55 per cent), and is an article of considerable commercial value. It is prepared on a fairly large scale at Ujjain in Central India. Besides

Caraway (*Carum Carui*)

thymol certain hydrocarbons, such as *thymene*, are obtained from ajowan oil and are used in soap perfumery. The distilled dry fruits contain 15 to 17 per cent protein and 25 to 32 per cent fat, so that they constitute an excellent food for cattle. [G. W.]

Caraway Cheese.—In some districts—more commonly in England in days gone by than now—certain fancy cheeses were made by

the addition of extraneous matters, such as sage, caraway seeds, or some other vegetable matter —one or more—to flavour and colour cheese for Christmas. In some Continental countries—Holland, Germany, Russia, and elsewhere—these adventitious and extrinsic additions to flavour, in any time of the year, are used to some extent in the making of cheese. It is all a matter of fancy; and to a simple, genuine taste in cheese certainly no improvement. But there are sorts of cheese that need extraneous aid to make them palatable, so inferior are they in that which constitutes quality. [J. P. S.]

Carbohydrates is a term applied to a large and important class of organic substances. They form the principal constituent of the dry matter of most plants, and to a smaller extent they are found in animals and animal by-products. They all contain the elements carbon, hydrogen, and oxygen, the hydrogen and oxygen being present in the same proportion in which they occur in water. They are subdivided into several groups according to their chemical composition; thus those substances having the composition $C_6H_{12}O_6$, or a multiple of it, include the sugars, which fall under the following headings:—

HEXOSES ($C_6H_{12}O_6$). Grape sugar or dextrose, mannose, gulose, fructose, galactose, sorbinose, &c.
BIOSES ($C_{12}H_{22}O_{11}$). Cane, milk, malt sugar, &c.
TRIOSES $C_{18}H_{32}O_{16}$). Raffinose, &c.

Besides the sugars, which contain 6 atoms of carbon, or a multiple of it, another large and important class of bodies exists, closely allied to the sugars, and into which they can be converted, having the composition $C_6H_{10}O_5$. They are called the amylaceous substances, and include starch, dextrin, cellulose, gums, &c. Lastly, the carbohydrates contain a group of bodies, with the formula $C_5H_{10}O_6$, namely the pentoses. These include the substances arabinose, xylose, ribose, and their homologues, &c., also some compounds containing a greater or smaller number of atoms of carbon than that contained in the above formula.

The carbohydrates comprise some of the staple foods of both man and beast. In the grains and other common concentrated feedingstuffs the hexose group largely predominates; the starch, dextrine, and the common sugars in this group are among the principal foods of man; whilst in the coarse fodders consumed by our domestic animals, the hexose group, including cellulose in particular, is largely represented. It is, however, accompanied by no inconsiderable amounts of substances belonging to the pentose group, to which the name 'furfuroids' is applied.

In the analysis of concentrated feedingstuffs, &c., the value of the carbohydrates for feeding purposes is not based so much upon the chemical composition as upon their solubility in dilute acid or alkali. Those carbohydrates being soluble in the solvents mentioned, are included in the easily digestible substances, and are grouped together under the term 'nitrogen free extract', whilst those substances which do not dissolve in dilute acid or alkali are designated crude fibre. The more common hexoses, such as starch, sugars, and gums, make up the nitrogen free extract, whilst cellulose largely makes up the crude fibre.

The function of the carbohydrates as foodstuffs arises from the fact that after their assimilation into the animal system they can be made use of in building up animal increase, or on oxidation evolve heat and energy for supplying warmth and mechanical power to the body.

The carbohydrates as a group are of vast commercial importance. As previously stated, they are found principally in plants. *Starch* or *amylum* is present in all green plants. It is first built up by the chlorophyll granules in the leaf from the carbon dioxide of the atmosphere, and afterwards stored away in the form of starch granules in grains, roots, tubers, &c. These starch granules have concentric markings, and the difference in these markings serves as a means of identifying some of the starches. Starch is a white powder, soluble in hot water, forming starch paste, but insoluble in cold water. It is readily converted into sugar by means of enzymes and dilute acids. Its uses are manifold. *Cellulose* is widely distributed in nature. It forms the membrane of plant cells; cotton fibre, elder pith, &c., being almost pure cellulose. It is used in making paper, gun-cotton, collodion, celluloid, &c. On continued boiling with strong acid it is converted into sugar. Dextrine or British gum is made by heating starch. Animal starch or glycogen is stored up in the liver.

The hexose sugars are mostly crystalline. They occur in all sweet fruits; on fermentation with yeast they yield ethyl alcohol. The biose sugars are readily crystalline and are sweeter than the hexose sugars. They occur in sugar cane, beetroots, and to a small extent in ripe fruits, in milk, and malt. Cane sugar is not easily fermentable with yeast, but it readily ferments after being hydrolysed with acids. Malt sugar occurs in malt, where it is formed by the action of the enzyme diastase upon starch during germination of the grain. Yeast ferments it into ethyl alcohol. Milk sugar occurs in milk, and the ferment *Bacterium lactis* converts it into lactic acid. The pentoses occur in straw, gums, &c. [R. A. B.]

Carbolic Acid.—Carbolic acid is chemically known as phenol or phenyl hydrate, and has the formula C_6H_5OH. It is the simplest of a class of bodies known as phenols, all of which are chemical derivatives of benzene and contain hydroxyl united to the benzene nucleus. What are known as the 'tar acids' are phenols, and carbolic acid is the simplest and the typical tar acid. It is obtained from coal tar, and is also found in the tar obtained by the destructive distillation of wood. Coal tar is subjected to fractional distillation, and the fraction known as the 'heavy oil' contains the carbolic acid. From this it is removed by treatment with soda. Crude carbolic acid obtained in this way always contains small quantities of other phenols or tar acids, such as the cresols, which are the typical constituents of creosote. Pure carbolic acid is a solid crystalline substance, 1 part of which is soluble with 15 parts of water. With a small quantity of water, however, it forms an

oily liquid, and it is this combination of phenol with a small proportion of water which forms ordinary liquid carbolic acid.

Carbolic acid is a poisonous, caustic, and antiseptic substance. It is very largely used as an antiseptic and disinfectant, but is also used in the manufacture of high explosives, colouring matters, and various other derivatives. Some of the most important modern high explosives used for military purposes are composed of derivatives of carbolic acid.

Carbolic acid is not now used so largely for dressing wounds as was at one time the case. The main objections to it are that it has a caustic action on the skin and tissues, and that if absorbed it is poisonous.

Many well-known disinfectants are preparations of carbolic. In some of the carbolic disinfecting powders it is combined with lime, and in others it is mixed with diatomaceous earth or *kieselguhr*. It is also made into various carbolic soaps. Some of these contain comparatively little carbolic acid. To be effective as disinfectants most of them should contain much more carbolic acid than is present.

The value of carbolic acid as a disinfectant has been questioned to some extent, and it is not now regarded with so much favour as formerly. It is recognized that in order to be effective against germs and their spores it is not sufficient to use very weak solutions. Even in saturated solution it is not effective against the spores of such organisms as those of anthrax, and to kill the bacteria of disease themselves it is necessary to use a solution of over 1 per cent strength. Carbolic acid disinfectants have now to a considerable extent been replaced by others which are more powerful and certain.

One of the main agricultural uses of carbolic acid is in the manufacture of sheep dips. Carbolic acid is a powerful insecticide, and its smell helps to keep off the attacks of insects. The so-called 'non-poisonous' or tar acid sheep dips are made from carbolic mixed with more or less of the other tar acids. Carbolic dips generally also contain soap and mineral oils. They also frequently contain sulphur. The tar acids used in making dips should not contain what are known as the tar oils. These injure the wool and depreciate its value.

Carbolic sheep dips, if properly made, are effective against the common insect pests of sheep, and leave the wool and skin in fine condition. They are sometimes combined with a certain amount of arsenic.

The term 'non-poisonous' applied to carbolic dips is to distinguish them from the arsenic or poisonous dips, but the use of this term is not justified. Carbolic acid, though not so powerful a poison as arsenic, is very poisonous. When taken internally by man or the higher animals it rapidly causes death, and many fatal accidents have been caused by the accidental consumption of liquids containing carbolic acid. Liquids containing carbolic acid should be regarded as poisonous and marked as such. [J. H.]

Carbon, Carbonic Acid, and Carbonates.—Carbon occurs in the free state in nature, but more abundantly in combination with other elements. It forms an essential constituent of all living organisms, and is directly involved in all the vital processes associated with growth in animal and vegetable life. The combustible portion of the solid material of plants and animals is largely composed of carbon; when burnt, the carbon is liberated in combination with oxygen in the form of colourless gases. The compounds composing this combustible material are very varied in their properties and constitution. The study of these compounds constitutes one of the great branches of the science of chemistry, namely organic chemistry; the term 'organic' being applied because it was once thought that the synthesis of these substances could only be brought about by the aid of living organisms. Though in nature it is true that organized matter accounts for their manufacture, it is equally true that at the present time many of them can be synthesized in the laboratory by artificial processes. The study of these compounds in the laboratory has opened up vast fields for chemical research, and has already resulted in discoveries of enormous commercial value and of great scientific importance. Their connection with agriculture needs no further emphasis, when it is pointed out that the science of feeding is really the study of the changes which these substances undergo when acting as food for animals. Besides the organic compounds of carbon, other important compounds exist, namely the carbonates, carbides, &c.

The element carbon occurs, as previously stated, in the free state in nature. It is a solid, infusible, and non-volatile substance, and it exists in three distinct forms, namely as diamond, charcoal, and as graphite. As diamond it is pure carbon, and when combusted in air the crystal first begins to blacken or char, it then slowly burns to a colourless gas, namely carbon dioxide, leaving no ash behind. Charcoal is a non-crystalline form of carbon, but it has very important physical properties.

Different kinds of charcoal are made, namely wood, animal, coke, lampblack, bone, &c. Some kinds are of greater value than others. Charcoal possesses some very important properties, one of the principal being its remarkable power of absorbing gases within its pores. Gases such as ammonia, carbon dioxide and the monoxide, hydrogen, oxygen, &c., are absorbed by freshly ignited charcoal without any chemical change occurring. On warming the charcoal the absorbed gases are evolved again. One volume of charcoal will absorb 171 times its own volume of ammonia gas, 67 times its own volume of carbon dioxide, and 18 times its own volume of oxygen gas, &c.

This absorptive property is made use of in absorbing disagreeable-smelling gases and odours; for this reason it is called a deodorizer. Besides gases, it has the power of removing organic coloured bodies from solution in water; thus in the manufacture of white sugar the vegetable colouring matter is removed in the refining process by charcoal. Charcoal is also used in the purification of water and many other processes. Some of the physical properties of soils are due to the presence of this substance. Bone black or

animal charcoal is perhaps the most absorptive form of charcoal. Lampblack is used in the manufacture of printer's ink, paints, polishes, &c. Graphite or plumbago is used in making the so-called lead pencils. See BONE BLACK, CHARCOAL, &c.

Carbon when burnt in air forms two gases, namely carbon monoxide and carbon dioxide; the former is produced when the element is burnt in an insufficient supply of air. It is very poisonous, and when mixed with air is explosive. It occurs in the gases of coal mines and is called firedamp. Carbon dioxide is formed when the element is burnt in plenty of air. It is a colourless gas and will not allow substances to burn in it, hence it is said not to support combustion. It is poisonous, and when breathed in large quantities produces death through suffocation. This gas occurs in coal mines as the result of explosions, and is called chokedamp. It is formed wherever carbonaceous matter is burnt in air, such as in the burning of wood, coal, illuminating gas, &c. It is present in the breath of all living beings, hence it accumulates in the atmosphere of badly ventilated rooms. It is a product evolved in the decay of organic substances. It accumulates in disused wells; it is given off when many carbonates are heated strongly—chalk, for example, on heating, forms quicklime and gives off carbon dioxide. It is a constituent of the atmosphere, though in varying amounts—generally more is found in the atmosphere of towns than that of the country. Its presence in the atmosphere is of vital importance to plant life, as it forms the supply from which the vegetable kingdom obtains its carbon.

If shaken up in water some of the gas dissolves, producing a solution of a slightly acid reaction, the acid formed being carbonic acid. Thus—

$$\underset{\text{Water.}}{H_2O} + \underset{\text{Carbon dioxide.}}{CO_2} = \underset{\text{Carbonic acid.}}{H_2CO_3}$$

More gas will dissolve if it is shaken under pressure with water; this is how many aerated waters are made.

Carbonic acid is very unstable, but it forms stable salts called carbonates. Solutions of the acid have a solvent action upon many substances. Thus rainwater during its passage through air takes up some of the carbon dioxide. On percolating through a chalk formation rainwater has a distinct solvent action upon the chalk, which goes into solution and forms what is called hard water. The slight disintegrating action of soil water and plant rootlets on soil and other particles may be due partly or entirely to the presence of this acid. In fact, a saturated solution of the acid has been used for estimating the amount of available plant food in soils.

The CARBONATES are of great importance both commercially and agriculturally. On the addition of an acid they all give off carbon dioxide, or in other words they produce effervescence. From an agricultural point of view, carbonate of calcium or chalk is the most important. It is a white amorphous substance and occurs widely distributed throughout the soils in Great Britain. It is insoluble in pure water, but soluble in water containing carbonic acid. Limestone is impure carbonate of calcium. It is also found in a crystalline form as the mineral calcite. Chalk acts as a base, and its presence is essential for the fertility of all soils. It is used extensively for manurial purposes.

The carbonates of the alkali metals are crystalline and soluble in water, and their manufacture is called the alkali manufacture. They are extensively used in the preparation of glass, &c. Carbonate of soda is washing soda. Basic lead carbonate is white lead, and is used in making paints. Various carbonates of the metals occur as minerals. [R. A. B.]

Carbon bisulphide.—Used as an insecticide for subterranean insects and for clearing corn and stores of insect life. It is a volatile and highly inflammable fluid, and must not be used or kept near a light or live electric wire, nor must any match, cigar, or cigarette be used near it or its fumes. It has proved of incalculable value in exterminating the Phylloxera or Vine Root Louse in France and elsewhere, and is equally effective for destroying the ground form of woolly aphis and other subterranean insects, ants, &c. As far as is known at present it does not seem to harm pupæ or eggs when employed in such quantity as would pay to use in even garden cultivation. It must be injected into the soil when the latter is wet, as it looses its killing power in dry ground. The actual fluid must not touch the roots, which would be harmed, but the fumes cause no injury. It is best injected at a depth of 6 in. by means of special injectors (Vermorel and M'Gowan injectors). The quantities to use in the soil vary from 1 to 3 oz. per sq. yd.; for trees, 2 to 4 oz. to each tree. Stored grain, &c., may be cleared of weevils, &c., by placing it in closed receptacles and using 1 lb. of the fluid to 1000 cu. ft. of space. It is best placed in several saucers on the top of the grain or stores, as the fumes being heavier than air descend into the mass. Its effects on the soil also appear to be beneficial to the growth of plants. [F. V. T.]

Carboniferous System.—This important system of strata gains its name from the frequent occurrence of coal among its beds, especially in the higher series. Forests of large plants, lower in organization than our typical modern trees, had begun in Devonian times to spread across the earth. In the Carboniferous period they had assumed such importance that their remains, where entombed in swamps or along shore-lines, ultimately formed coal seams from a few inches to several feet in thickness. In Europe the Carboniferous period opens as a rule with marine deposits. In the north of England, however, in the county of Antrim, and in southern Scotland, coal seams occur even among the lower beds. Since coal-mining is likely to yield larger profits than agriculture, the farming area on Carboniferous strata becomes correspondingly restricted, and huge 'tips' of shale and sandstone are allowed to spread over the ground, round about the smoky chimneys of the mines. In midland England these 'tips' have been in recent years planted in some places with trees.

The typical succession of strata in South Wales and south-western England, excluding the abnormal series in Devonshire (see art. CULM MEASURES), is as follows:—

Upper Carboniferous sub-system.	5. Coal Measures Series. 4. Millstone Grit Series.
Lower Carboniferous sub-system.	3. Upper Limestone Shale. 2. Carboniferous Limestone. 1. Lower Limestone Shale.

The three lower series are sometimes conveniently grouped together as the Carboniferous Limestone Series.

As we go northward, grits and sandstones, with some coal seams, become frequent on the level of the Upper Limestone Shale, and this set of beds has received the distinctive name of the Yoredale Series. The Pendleside Series of Messrs. Hind and Howe (Quart. Journ. Geol. Soc. London, 1901, p. 347) covers, however, beds

Carboniferous System.—Distribution of British Coalfields

in Lancashire and elsewhere which were previously classed as Yoredales, and the fossils of this series are of Upper Carboniferous type. Hence in recent years the base of the Upper Carboniferous sub-system has been shifted down in certain places, and it has been recognized that the Yoredale type of rocks may be repeated in the Upper Carboniferous. It is urged, moreover, that the true Yoredale Series is represented in Lancashire (Pendle Hill, &c.) by the upper part of the Carboniferous Limestone. Indeed it is clear that in adjacent parts of the marine area limestones, sandstones, and shales were being deposited simultaneously, producing in our day a great diversity of scenery and soils on the same geological series. The Millstone Grit was formed as a remarkably extensive shore deposit throughout the English area. With the epoch of the Coal Measures Series we reach true swampy conditions, and even dry land; and the forests assert themselves freely, their remains forming excellent coal seams among shales and sandstones. In some countries, as in a vast tract stretching from Russia eastward,

the whole Upper Carboniferous strata are typically calcareous and marine.

At the close of Carboniferous times earth movements set in throughout Europe which wrinkled the strata in a series of folds, mainly running from east to west. Some areas sank in; others remained as great blocks above the general level; while denudation proceeded to wear away the crests of the folds that were formed in the crumpled regions. Hence the higher Carboniferous beds, including an immense amount of coal, have often been denuded away, exposing the lower series, which is more suited for agricultural operations. The *coalfields*, or areas rich in coal, owe their preservation to local accidents, such as the lowering of the Coal Measures into the troughs of earth-folds out of reach of the severest denudation. Hence the Coal Measures cannot now be continuous over any vast area, and the occurrence of coal beneath one farm is no proof in itself of its existence beneath adjacent lands. So much money has been lost by reckless sinking in search of coal, that too much stress cannot be laid on the necessity in all cases for consulting geological maps and memoirs, where such have been published. Where the beds contain fossil organic remains, a reasonable judgment may be formed; but it is always desirable to refrain from expensive operations, if the mere ground for sinking is that the rocks are said to look like those associated with coal in some other and perhaps remote locality.

The most striking contrasts of landscape and surface conditions occur in different Carboniferous areas in our islands. The mass of limestone in the lower sub-system, sometimes 3000 ft. or more in thickness, gives rise to plains and plateaus, and the latter are cut into deeply by the streams, as is well seen in the 'dale' country of Derbyshire. The water rises in unexpected places, and often disappears as unexpectedly into the ground. The streams, owing to the solubility of the limestone in water charged with carbon dioxide, literally dissolve out their own channels, and pursue a course partly above and partly below the ground. Some of the deep ravines in the limestone, which now lie open to the day, may have been at one time subterranean channels, the roofs of which have fallen in. 'Swallow holes' often appear in the upper fields, and increase gradually as the surface falls in towards some underlying cavern formed by solution of the rock below. In many cases these swallow holes become too steep for tillage, and are abandoned to small trees and undergrowth.

The vertical joints in the massive limestone give a wall-like character to the weathered surface of the valley sides, and the occasional bands of shale provide alternating gentler slopes. Grey scarps thus often rise above grassy banks on which cattle pasture. The upper surface of the limestone plateaus is often desolate enough, especially where it is wind-swept, and the bare rock may be exposed over wide areas.

The Carboniferous Limestone forms the mass of the Mendip Hills, an east-and-west ridge, typical of the system of folding that can be traced from Kerry across Europe. Outliers of marine Jurassic strata now modify the farm lands on its crest. The Bristol coalfield lies in a downfold to the north; while nearly the whole Carboniferous system is seen across the Severn in the Forest of Dean, an island-like mass rising from a lowland of Old Red Sandstone. A true forest remains upon its plateau, some 600 ft. above the sea, and the Coal Measures are worked in mines concealed among the trees. The great coalfield of South Wales lies to the west, bordered below by Carboniferous Limestone, like the Forest of Dean. The Coal Measures come to light, forming hummocky tumbled country, in several areas in central England, through the covering of the Triassic plain. The contrast between these Coal-Measure areas, supporting smoky but prosperous towns, and the adjacent agricultural country of the New Red Marl and Sandstone, with their red brick cottages and quiet orchards, is noteworthy throughout midland England.

The beds of the Millstone Grit Series give rise to scarps and terraces still more emphatic than those of the Carboniferous Limestone. They form a striking and barren escarpment, facing west, above the fertile Triassic area of the Cheshire plain.

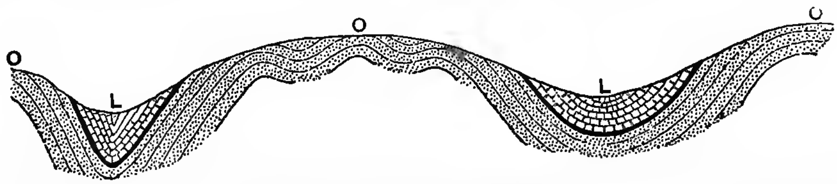
The Pennine Chain, an upfolded mass running northwards from Staffordshire, exposes the whole Carboniferous system on its denuded surface. The Carboniferous Limestone in the core forms the dale-and-plateau country of Derbyshire, which has been before referred to. On its east and west flanks the overlying grits produce scarps, with long dip-slopes falling to the South Yorkshire and Lancashire coalfields respectively. The limestone area in the centre is now quarried on an enormous scale, and the smoke from the limekilns almost rivals that which creeps up from the industrial areas of the coalfields. The proximity of the latter is seen by the blackness of the vegetation on the Millstone Grit moorlands, and of the wool of the sheep that pasture there.

Still farther north, the Millstone Grit Series forms the crest of the great arch, in the high bleak plateau of the Peak; but it is again cut through, so as to expose the limestone, in a wide area from central Westmorland to beyond Richmond in Yorkshire. Here we find the typical Yorkshire moorlands, great swelling rolls of country, with clear and noble streams running eastward in the valleys. The country is still wilder as we enter Durham, while the Durham and Newcastle coalfield lies at a lower level on our right, repeating that of South Yorkshire. A bleak open pastoral upland rises from the Tyne towards the Cheviots, the Carboniferous Limestone Series prevailing everywhere; but here coals occur in this series, and sandstones and shales frequently predominate over limestone.

A broad downfold has preserved Carboniferous beds in the basin between the Forth and the Clyde. The lower series are not so rich in limestone as those of central England, and the Calciferous Sandstone Series at the base contains much red and yellowish sandstone. Coal Measures are found in a broad moorland tract between Glasgow, Lanark, and Linlithgow, and again from the coast at Ayr northward to Ar-

drossan, and eastward as far as Muirkirk. Here the Limestone Series again emerges, and the Old Red Sandstone beneath it forms a barren upland on the divide between the two coal basins.

At Ballycastle in Co. Antrim, sandstones of the Scottish Lower Carboniferous type occur, with workable coal seams, and these sandstones, though without coal, spread over certain areas, south and west, in the counties of Londonderry and Donegal. North-west of Donegal town they form a bleak upland of poor and peaty soils. The Carboniferous Limestone in Ireland rises in high scarped masses near Sligo, with green grassy tables reminding us of those of Derbyshire. In the north of Clare, bare windswept terraces occur, forming considerable hills; but in general the Irish limestone has been worn down to an almost level surface by long ages of denudation. Broad bogs have gathered on the superficial boulder clay, and sometimes on water-logged areas of the limestone; lakes with low shores, caverns, and disappearing and reappearing streams, are frequent features. The great grazing lands of central Ireland have been naturally established on this vast limestone area, which practically stretches from sea to sea. In the south, the earth-folding has brought up the barren Old Red Sandstone along east-and-west ridges; the limestone, with shales below it, has, however, escaped denudation along the downfolds, and cultivated and wooded lands, with streams flowing along them, thus stretch east and west between the heather-covered ridges of the sandstone. In Co. Cork, the Carboniferous Slate represents the Carboniferous Limestone Series, and angular fragments from it mingle freely with the soil. Millstone Grit and Coal Measure strata give rise to poor lands in West Limerick and Clare, and occur in high moorland outliers above the terraced limestones



General section in Southern Ireland, showing Troughs of Carboniferous Limestone (L) with Shale below, downfolded between masses of Old Red Sandstone (O), which rise as barren hills. The main cultivation occurs along the hollows, while the soil is rendered lighter by downwash from O over the shales.

near Lough Allen; other coalfields occur near Dungannon and on the high plateau north of Kilkenny. The Upper Carboniferous beds, however, have suffered so greatly from denudation that there is little lack of limestone exposures throughout the greater part of Ireland; and small limekilns, used from time to time, are dotted freely about the country. [G. A. J. C.]

Carboniferous Soils.—The shales and clays of various tints, which occur at the base of the Carboniferous System (Lower Carboniferous Shale Series), form poor, stiff, yellowish or reddish coloured soils, very similar in character to those of the Coal Measures. As the rocks of the series are soft, they break down rapidly, to produce retentive and generally unmanageable and unprofitable clays. The strip of land in Durham extending from Cockfield to Woodland is of this nature, and is sufficiently representative of the series (M'Connell, Agricultural Geology, p. 177). In general, these soils are poor in lime, although bands of limestone sometimes occur interbedded among the shales. Similar limestones occur in the Calciferous Sandstone Series of Ireland, but do not seem to have a very marked effect on the fertility of the districts (Kilroe, Soil Geology of Ireland, p. 83). The Scotch Calciferous Sandstone soils are to be found on the northern shores of the Firth of Forth, reaching from Seafield along by Kinghorn, Burntisland, and Inverkeithing, as far as Charlestown. These soils are deep and dark-coloured loams of great fertility, and are for the most part under cultivation.

The lands of the Carboniferous or Mountain Limestone Series form a pleasing contrast with all the others of the Carboniferous System. Their pastures especially are remarkable for their sweetness and general excellence, and, even in the elevated districts of Derbyshire and Cumberland, they support a valuable herbage which is much favoured by sheep. The nutritious Sheep's Fescue (*Festuca ovina*), a grass well adapted for such dry and exposed situations, is the most conspicuous plant of these mountain pastures.

Unlike most other directly derived soils, that from limestone is not produced from the debris of the rock as a whole, but almost entirely from the impurities it contains, which remain behind after the carbonate of lime has been removed by solution (see art. Limestone). Phosphates are usually present, and the fact that potash becomes more available in the presence of a high percentage of carbonate of lime adds to the fertility of limestone soils.

The most prevalent variety of Carboniferous Limestone furnishes a loose friable loam, which is usually thin, owing to the great thickness of strata that must disappear in order to provide the material necessary for even a few inches of soil. Often, in exposed places, no soil whatever collects on the surface of the rock. Such a phenomenon is well seen in the Burren district in Co. Clare. Many varieties of limestone produce soils which are stiff and clayey, especially if they contain muddy impurities, like the earthy limestones of the Dublin area.

The great bulk of the Carboniferous Limestone area of the British Isles is under permanent pasture, but, as in Somerset, Gloucester, and Cumberland, where the soil is of reasonable depth, good crops of cereals, turnips, and hay may be grown.

The porous nature of the underlying strata ensures a dry condition of the soil, which brings about an early harvest. In Ireland the limestone of the country is mostly covered with glacial drift, and comparatively few of the soils within the area have been formed *in situ*. The Carboniferous limestones of the Lothians, in Scotland, are also drift-covered, and the soils are further modified by an admixture of the detritus of dykes and hills of basalt, which contribute much valuable fertilizing matter to the lands of that famous agricultural district.

In Co. Cork the Carboniferous Slate, with its associated sandstones, gives rise to stony loams which are excellent for both tillage and pasture. Mr. Kilroe notes that they are often beneficially affected by an admixture of the adjoining Old Red Sandstone material, or by a reinforcement of limestone drift (Soil Geology of Ireland, p. 85).

The soils of the Yoredale Series are of very little agricultural importance. The shales produce a stiff, wet, black clay, while the sandstones of the formation also furnish soils of very inferior quality. Both the shales and sandstones are covered with a coarse, worthless vegetation, in which furze, heath, whortleberry, and sorrel predominate (M'Connell, Agricultural Geology, p. 181).

The Millstone Grit Series usually occupies high ground in a Carboniferous area, and is singularly free from any covering of glacial drift. For either pasture or tillage the soils furnish poor material, although with liberal treatment fair, if not always profitable, crops can be raised on them. Ordinarily, however, the land is left uncultivated, and when swampy, as it is where the substratum is impervious, the ground is occupied by heaths and moor. The soils are sands or gravels that are almost destitute of fertilizing materials.

Associated with the Coal Measures we find wet, poor, stiff, yellow clays, supporting an inferior herbage, in which heaths and sedges play a prominent part. In some places, where the beds are more micaceous and sandy, the soils are much looser, but often even here the drainage is bad. An application of lime in connection with thorough under drainage has a very marked effect in the improvement of these lands; but chemical analysis reveals a deficiency of some of the most important food materials, and a liberal application of manure is thus also necessary as a preparation for the growth of remunerative crops. [T. H.]

Carcass.—The butcher when buying animals for slaughter has always to consider what the weight of the carcass will be. This is not very easy to ascertain; there are three methods of estimating the dead weight or carcass weight of an animal.

First Method.—By carefully handling certain parts of the animal, and as the result of that handling, the butcher judges by eye and brain what he thinks the carcass of an animal will weigh.

Taking an ox for an example, the butcher handles the following parts, viz. brisket, flank, scrotum (or cod), the muscles behind the shoulder, the ribs, the loin, and the amount of flesh on the pelvic bones (*tuber ischii*) at each side of the tail. In calves, much the same handling takes place.

In sheep, the butcher generally handles the loins by spreading out his hand over them in the region of the kidneys, to ascertain the development of the muscles there (*longissimus dorsi*, &c.); he then lifts the animal up carefully, and slowly turns it over his knee, at the same time estimating how heavy it will weigh; setting it down on its hind quarters, he feels the brisket as to the development of the muscles there.

In pigs not much handling is done, the weight being judged principally by the eye and brain of the butcher. Needless to say, this method requires a keen eye for detail, an active brain, and long experience to become an adept; but the fact that the butcher earns his living by this judgment no doubt sharpens his wits, because if he estimates the carcass to weigh more than it does, he has to pay pretty heavily for his mistake.

Second Method.—This is a method of estimating the dead weight of an animal by measuring certain parts of its body. Mr. J. Ewart, in his Meat Production, gives very full details of this method; but to meet the variations in weight occasioned by the variation of form characterizing breed, it was found necessary to divide the varieties of cattle into several classes. After classification as to breed, the conditions as to state of fatness had to be considered—as half fat, moderately fat, prime fat, very fat, and extraordinarily fat. This embraced so many details that the method is very seldom used in buying and selling fat stock. It has been superseded by the

Third Method.—This is the method of weighing the animal alive, and by carefully prepared tables calculating the percentage of dead weight as compared with the live weight. It is a method highly spoken of by some people and not approved of by others. Although the method has been in vogue for a number of years, it has not made very great progress in Great Britain in supplanting the older method of the butcher. Proof of this is evident in some cases, such as at the Foreign Cattle Market, Deptford, London, where it is quite a common thing on a market day to see over 2000 cattle sold in less than two hours, not one of which has crossed over a weighbridge, the judgment being done by eye. The weighbridge is in use at the Metropolitan Cattle Market, Islington, London, where home animals are sold, but it is not much used. On the other hand, at many of the auction marts in Scotland all the cattle pass into the ring over a weighbridge, the weight being shown on a dial. Cattle are more often sold by live weight than sheep.

Before calculating the weight which one expects to get in the carcass, it is necessary to note that some feeders bring their cattle to maturity much quicker than others, and the percentage of dead weight to live weight depends on the class of food supplied to the

animals. It is not an uncommon thing to hear butchers say Mr. So-and-So's cattle always weigh what you reckon them. Only a few years ago (and even now in some cases) it was customary to allow young cattle to run about until they were three or four years old before attempting to fatten them for the butcher, but the present up-to-date farmer has adopted the methods of the United States feeders of feeding off cattle when very young. Examples of this may be seen at Birkenhead, London, and Glasgow, nearly every week 'baby beef' being shown. These animals are under two years of age, yet in prime condition. Samples of what can be done in this country are seen at our fat-stock shows at Christmas. Mr. M'Jannett of Woodlands, Stirling, N.B., has done much to get the farmer to sell his animals to the butcher by the live-weight method, and in his carefully compiled book he says that in sheep the percentage of dead weight varies with the breed, but the average may be taken as being nearly correct, his figures being 51 per cent of mutton. Young fat pigs, he found, will dress 62½ per cent to 70 per cent, while prime fat pigs will dress 67½ to 77½ per cent. These experiments or tests were conducted on his own farm, and he notes that sheep fasted for twenty-four hours or journeyed to market lost from 7 to 12 lb. of live weight.

Lawes and Gilbert found that on an average the dressed weight constituted the following percentages of the live weight: Fat oxen, 59·8; fat calves, 63·1; poor sheep, 53·4; very fat sheep, 64; fat pigs, 82·6 per cent. Hengst, in the cattle yards at Leipsic during a period of three years 1889–91, found as follows: Oxen, 53·4; heifers, 55·9; cows, 48·4; bulls, 54·3 per cent. In 1898 he found: Oxen, 53·6; heifers, 51·3; cows, 50·8; calves, 69; sheep, 53; and pigs, 86·5 per cent; while in weighings of eighty-eight well-fattened cattle made by the German Agricultural Society in the Army Conserve Factories at Mainz and Haselhorst, the highest dressed weight was 63·3 per cent of the live weight. Incidentally, the animal which showed this high-dressed weight was affected with generalized tuberculosis. In the meat markets of Berlin it is customary to deduct 20 per cent of the live weight where pigs are sold according to dressed weight (Ostertag). Many more figures could be given, but in all of them there is an amount of variation, and, as Mr. M'Jannett says, condition must remain a matter of judgment. Inferior cattle will dress less and prime cattle more than the figures in his tables, so that in any of the methods the practical judge will always have the advantage.

Before calculating the weight of carcasses the undermentioned portions of the animals, together with organs named, must be excluded, viz.:—

In Cattle.—The skin or hide, tail, head, feet taken off at the first or lower joint of the carpus and tarsus (that is to say, immediately above the shin bones). The organs contained within the thoracic (chest), abdominal (belly), and pelvic cavities, with the fat attached to them, except in the case of the kidneys and their surrounding fat. In some districts the kidneys are taken out during the dressing of the carcass. The bloodvessels along the spinal column and in the interior portion of the thorax, together with the attached tissues: this, again, varies in different localities, as in London a considerable portion of the posterior aorta is left attached to the carcass. The tendinous portion of the diaphragm: here, again, in some districts and cities, the pillars of the diaphragm (or thick skirt) are left attached to the carcass. The spinal cord (not always); the penis and testicles of bulls, the penis of oxen, the udder in old cows but not in heifers.

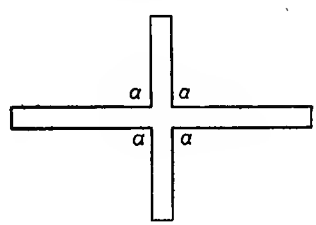
In Calves.—The skin, head, feet (taken off in the same way as in oxen); the organs of the thoracic, abdominal, and pelvic cavities; the navel and the external sexual organs of bull calves.

In Sheep.—The skin, head, feet (taken off as in oxen); the organs of the thoracic, abdominal, and pelvic cavities, with the exception of the kidneys (in London and some other places the kidneys are taken out); the external sexual organs of tups and wethers, and the udder of ewes.

In Pigs.—The organs of the thoracic, abdominal, and pelvic cavities, together with the tongue (but not always the tongue); the kidneys and peritoneal fat are left in the carcass. In weighing cattle the carcass may be weighed in sides, in quarters, or as a whole.

In weighing sheep and calves the carcass is weighed as a whole. In weighing pigs this is generally done as a whole, but in the case of big old boars and sows they may be weighed in sides; and here it may be noted that in some parts of this country large boars and sows may be skinned, and in that case the skin is not weighed with the carcass. If the carcasses of cattle are weighed while warm, a deduction of 1 lb. per cwt. is allowed. [T. D. Y.]

Carcasses, Destruction of.—There is no surer method for the eradication of specific



disease than destruction by fire of all diseased carcasses. The process is expensive in the case of the larger animals, but it is eminently satisfactory, and is time-saving compared with the labour of digging deep trenches for the reception of the bodies. Cremation may be carried out in the field or in a suitable incinerator, which is in some parts provided for the purpose. Field cremation is easily carried out. Trenches are dug in the ground in the shape of a cross, as in the accompanying figure. Each trench is 7 ft. long, about 15 in. wide, and 18 in. deep at the centre, where the two meet,

becoming shallower as they rise to the surface of the ground. The earth is mounded in the centre at each angle formed by the trenches, *aa*, and two iron lathes are placed on top of it. The necessity for the trenches is that they provide a suitable draught.

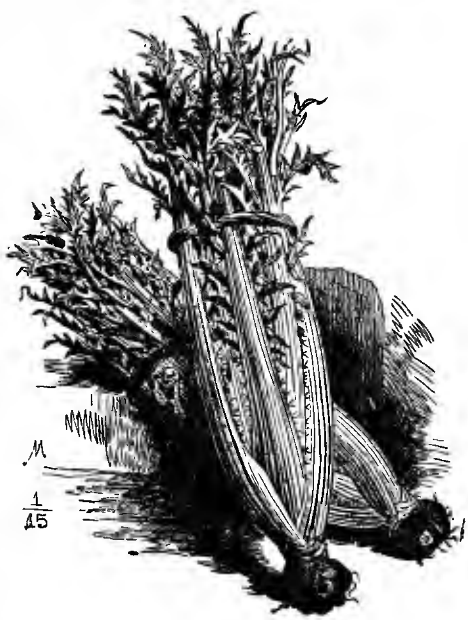
Bodies may be burned whole or in pieces. The quicker method is to eviscerate the animal and remove the limbs. The trunk is placed on a few pieces of stout wood, which act as a base; more wood is added, on which the limbs are placed, then another lot of wood supporting the viscera. With paraffin and straw the pile is lighted, and in six or eight hours the animal is consumed. The trench ought to be raked out from time to time to allow for the draught of air. In some cases it is not advisable to open the body before cremation, as, for instance, in the case of anthrax. It is indeed forbidden by law to eviscerate the carcass of an animal suspected to have died from anthrax. [H. L.]

Cardamine pratensis, a cruciferous weed, commonly called Lady's Smock or May flower. See Lady's Smock.

Cardamom.—In Eastern agriculture there may be said to be at least two plants that afford cardamoms—a spice which consists of the seeds obtained from dried leathery fruits or capsules, and is used in medicine, cookery, confectionery, &c. The true or lesser Cardamom, the Malabar Cardamom, is the fruits of *Elettaria Cardamomum*, and the so-called greater Cardamom those of *Amomum subulatum* of Nepal. Both are perennial herbs that belong to the nat. ord. Scitamineæ, but the latter is only a poor substitute for the former, and this may be said to be the case with all the other substitutes. The true Cardamom is indigenous to western and southern India, and is cultivated from 500 to 5000 ft. in altitude, in Kanara, Mysore, Coorg, Wynaad, Travancore, Madura, Burma, Ceylon, and Java. It is essentially a plant of the Tropics, and even there is confined within very narrow limits. There would appear to be two forms—the Malabar and the Mysore.

A fairly deep, rich, loamy soil, resting on rock and located within undulating land in close proximity to running water, is indispensable. Shade and humidity are also essential, for the plant luxuriates in mists and fogs and cooling sea breezes. It thus follows that the areas of production are not numerous, and even within Malabar—the home of the plant—there are only certain tracts that are what might be called specially favourable. There may be said to be two methods of cultivation: (*a*) *Forest Production.*—Spaces are cleared in the jungles, weeds uprooted, and if cardamoms do not already exist as semi-wild plants, root cuttings are planted in February–March here and there all over the plot. An occasional weeding is given, especially around the plants, and by September–November of their third year a first crop may be obtained. For three to five years subsequently crops are gathered, and thereafter the plot abandoned and a new clearance made. This is the system that as a rule prevails in Malabar and in some parts of Mysore, where cardamom production is occasionally made an auxiliary to coffee-planting. (*b*) *Agricultural Production.*—Cardamoms may be spoken of as extensively grown in the betel-palm and pepper gardens of western India and Mysore. In Kanara the crop is chiefly raised from seed, the sowing taking place in September–October. The seedlings are often transplanted into rice seed-beds, shaded by palm leaves. When eighteen months old they are carried to their permanent positions, either in March–June, or again in September–October. The plants are placed in pits, about 2 ft. apart, and richly manured, the manure, very largely leaf mould, being repeated every March–April. The flowers appear in May, and the fruits are in season in September–October.

The fruits have to be carefully severed just before fully ripe, since the pressure of the finger in plucking fully ripe fruits would cause them to burst and to be thus injured commercially. After being dried in the sun carefully for two or three days, the fruits are hand-rubbed to remove the stalk, calyx, &c. A fully stocked plantation may contain 300 to 400 Cardamom plants to the acre, each yielding up to half a pound of dry cardamoms. If reliance can be placed on the available statistical information, there would appear to be an annual production in India of about 2,000,000 lb. The exports from India during the past five years have shown an expansion in quantity and shrinkage in price. But India is itself the most important market in the world for cardamoms, hence it imports, from Ceylon mainly, half a million of pounds, or just a little more than the quantity exported. [G. W.]



Tours Cardoon

Cardoon (*Cynara Cardunculus*), a perennial related to the artichoke, and probably descended from the same species. It is larger,

however, than the artichoke, the stem attaining a height of from 4 to 6 ft. The leaves are large, pinnatifid, with yellow spines on the margins. The fleshy leaf-stalks are the parts that are used as food, and when blanched and properly cooked they are excellent. The flowers have the property of curdling milk. The plant prefers a light, rich soil; it is raised from seeds sown on the open border in April or in a frame, the seedlings being transplanted. Trenches 1 ft. deep, as for celery, should be prepared, and the plants set in them 1 ft. apart. They like plenty of water in dry weather. They must be earthed up as for celery, or they may be blanched by placing a drain pipe over them and filling up with sand. On the approach of frost they must be lifted and placed close together in a cellar, where they will keep good till March. [W. W.]

Carduus, a genus of thistles, the species of which are either annuals, biennials, or perennials. They are sometimes cultivated for massing in what is known as the wild garden. Generally, however, they are too coarse and weedy to be classed among decorative garden plants. See also THISTLES. [W. W.]

Carex, an extensive genus of weeds belonging to the nat. ord. Cyperaceæ and commonly known as sedges. See SEDGES.

Caribou (the American Reindeer, *Rangifer caribou*).—This deer ranks in size next to the moose and elk, and occurs in the most northerly parts of North America, inhabiting Canada up to the Arctic coast. There are several races, named according to their habitat, and differing chiefly in regard to size and branching of the antlers, but showing much general resemblance to one another, and to their Old World congener the Lapland reindeer. In all, branching antlers, which are shed annually, are borne by both sexes; the characteristic palmated brow-tine, pointing downwards, is well developed on one side, occasionally on both; the legs are short and thick, the hoofs short, round, and widely spread, enabling the animals to pad along with great rapidity over swampy ground, and even over deep snow. Reindeer moss forms their staple food in winter, but in summer all sorts of shoots, grasses, &c., are eaten. The Caribou are much hunted and trapped for the sake of their valuable skins, and they are rapidly growing scarce in all but the most inaccessible parts of their range. Two distinct types are the Woodland Caribou (*R. caribou*), a large, heavy animal of a dun colour marked with white, and the Barren Ground Caribou (*R. greenlandicus*), which is very much smaller and lighter in build, but has larger antlers. This species migrates in May to the shores of the Arctic Ocean, returning inland in September. Its flesh is highly prized, and is much used by Canadian trappers in the form of pemmican. [J. A. T.]

Carnallite, one of the most important of the 'potash salts' of Prussia; a hydrous chloride of potassium and magnesium ($KCl.MgCl_2.6H_2O$). When pure, it contains 26·8 per cent by weight of potassium chloride, or 14·1 per cent of potassium, as against nearly 19 per cent of potassium in kainite. It is easily soluble in water, and takes up water, thereby liquefying in damp air. In the Stassfurt deposits, the Carnallite bed contains rock-salt, gypsum, and kieserite (hydrous magnesium sulphate), but yields about 60 per cent of carnallite, equivalent to about 15 per cent of potassium chloride, or about 9·8 per cent of potash (L. A. Groth, The Potash Salts, 1902, p. 96). This bed is the great source of commercial potassium chloride (often styled muriate of potash), which is extracted from it and applied as a fertilizer to the land. The commercial 'muriate of potash' thus prepared contains some 70 per cent of potassium chloride, equivalent to 45 per cent to 50 per cent of potash. [G. A. J. C.]

Carnation.—Several distinct races of garden plants, known as carnations, picotees, and pinks, owe their origin to the wild *Dianthus Caryophyllus*, of which there were named varieties in cultivation in this country over 300 years ago. The section generally known as carnations comprises Malmaisons, remarkable for the large size of the flowers and robust habit of the plant; Tree carnations, usually grown in pots for conservatory decoration or for cut flowers; and Border carnations, of which the Clove is a familiar example. Great improvement has been made in the Tree, or, as they are now termed, the winter-flowering section, the choicest of them having been raised in America. Although grown under glass to flower in winter, these carnations are useful border plants. Starting with the rooted layers in October, they may be planted where they are to flower. They prefer a good loamy soil, enriched with well-rotted stable manure. If the soil is heavy, lime rubbish may be mixed with it advantageously. Rabbits greedily eat carnations, as also do many birds, even sparrows often proving troublesome. They are also subject to several fungus diseases, and eelworms and wireworms are very partial to their roots. A carnation border may be the most delightful feature in the garden, a collection of the best sorts yielding flowers continuously from June till September, or even later if they are properly managed. They ripen seeds readily, and these may be sown in March or April under glass, the seedlings being pricked off when about a month old in boxes or frames. These, if transferred to the borders during moist weather in July, will flower the following summer. Another section, known as Marguerite carnations, may be grown as annuals, the seeds being sown in February under glass, and the young plants put out in the open at the end of May. Named varieties of carnations are propagated from layers which are pegged down in August the lower part of the stem being covered with a fine, light soil, which should be kept moderately moist, and by the autumn they will have rooted and be ready for removal from the parent plant. [W. W.]

Carnation.—Parasitic Fungi.—

LEAF-SPOT.—The most common form in Britain is that commonly known as the 'fairy-ring spot' from the concentric circles formed by the greyish-brown spore patches of *Heterosporium*

echinulatum. The spores thus produced propagate the disease during summer, and the formation of resting bodies or sclerotia in dead remains ensures its passage from one season to the next. A check in growth such as results from cold, dull weather is said to favour this disease.

LEAF-RUST, due to *Uromyces caryophyllinus*, has caused much loss in the United States; other rust fungi have been observed in Britain. The rusty appearance of the foliage is caused by patches of yellowish or brownish spores; the mycelium lives inside the tissues and stunts the growth of the plants. Rich nitrogenous soils and indoor cultivation favour rusts.

ANTHRACNOSE AND BACTERIOSIS.—The symptoms are general weakness and failure to produce blooms. Several distinct forms of the disease have been recognized, some consisting of leaf discoloration alone, others being accompanied by rotting of the neck. The conditions favourable to attack are overcrowding, insufficient ventilation, and moisture lodging on the foliage.

Treatment.—Altogether, about sixty distinct fungi have been found on carnations, but the treatment for all is much the same. The Carnation requires free access of air to its foliage, although its natural tendency to spread along the ground leads to overcrowding. Where grown under glass on a large scale, a useful device is to place under the foliage pieces of wire netting bent into ʌ shape; besides assisting ventilation, this also allows the roots to be watered by a hose without wetting the foliage. Only clean, healthy plants ought to be used for layering or cutting. If, in spite of all precautions, leaf-spot or rust appears, spraying the plants every few days with potassium sulphide (1 oz. in 3 gal. of water) is recommended by a well-known grower, who also advises isolating the plants if possible. [W. G. S.]

Carnation Grass is the name for a species of sedge (*Carex panicea*) with wax-covered leaves resembling those of the garden Carnation; it frequently grows in wet pastures and marshes. The plant is a tufted perennial, with stems 1 or 2 ft. high, which flowers in May and June. The ear at the end of the stem is usually composed of three spikelets, which are wide apart, stalked, and separated by sheathing leaves. The terminal spikelet is barren, the other two fertile. The fertile spikelet is cylindrical, ½ or ¾ in. long; its chaff (*glumes*) is dark-brown, and the husk (*perigynium*) enclosing the triangular nut is greenish-brown, without veins. [A. N. M'A.]

Carnivora.—This large and important order of mammals is well represented by four well-known types—cat, dog, bear, and seal. The aquatic Pinnipedia (seals, sea lions, and walrus) are so different from the terrestrial Fissipedia (cats, dogs, bears, &c.), that a definition which covers both is apt to lack point. We may refer, however, to the possession of claws, and of teeth adapted for carnivorous habits, to the strictly up-and-down movement of the lower jaw, to the vestigial nature or absence of the clavicles, to the well-developed cerebral hemispheres, to the external testes, abdominal mammæ, bicornuate uterus, and zonary placenta. [J. A. T.]

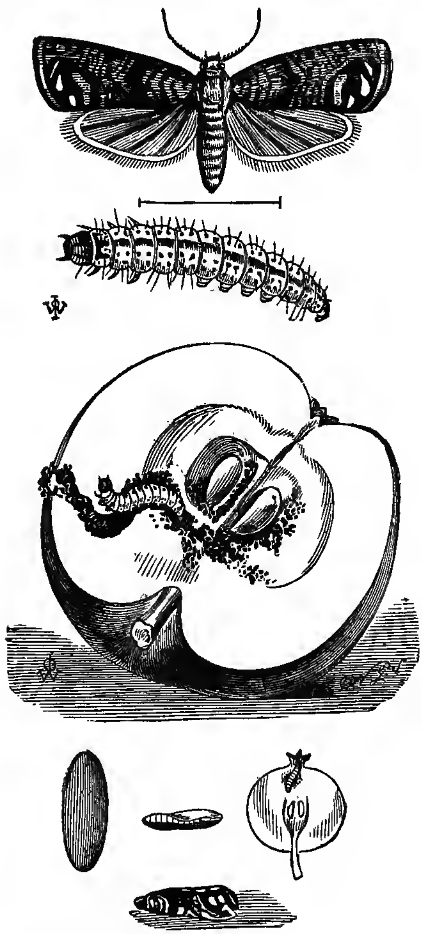
Carob Tree (*Ceratonia Siliqua*), a small, slow-growing evergreen tree which belongs to the Leguminosæ. It is indigenous to the eastern Mediterranean regions, to Syria and Western Asia generally, but is now cultivated in most warm, temperate, and tropical countries. It may be spoken of as of recent industrial value, having been carried throughout the world largely on account of its great reputation among the Arabs. It becomes naturalized in a hardy, less productive form that has to be grafted with the better fruit-yielding stocks. In regions subject to periodic droughts it is of special merit, since its long roots penetrate to such a depth as to render it independent of atmospheric conditions. The pods are known as carob beans or sugar beans. They contain a sweet, nutritious pulp, hence their being a common article of food for horses, pigs, cattle, and the finer forms even with men. Professor Church gives them the nutrient ratio of about 1:8·5, and the nutrient value of 68. The pods form accordingly an important ingredient in certain special cattle foods. They are supposed to be the 'husks' of the prodigal son and the locusts of John the Baptist, hence the names locust beans and St. John's beans. [G. W.]

Carotid Artery.—The carotid arteries are branches of the common carotid, and their course is up the channels of the neck behind or more deeply seated than the jugular veins, from which it is customary to abstract blood when systemic bleeding is deemed desirable. [H. L.]

Carpinus. See HORNBEAM.

Carpocapsa pomonella (Codling Moth and Apple Maggot).—The so-called 'maggot' in apples is the larva of this moth. It causes endless loss in apple orchards in all countries where these exist. Its presence is easily detected, first by a small quantity of granular 'frass' (dung) that adheres to the 'eye', later by a large round hole on the fruit, with wet 'frass' sticking to it. The fruit may fall when young (summer fall), or may remain on the tree until the larvæ have matured. The moth appears in June and July, and again in August. Its wing expanse is ¾ in.; the fore-wings are grey with darker transverse wavy lines, and a bright metallic spot at the corner; under-wings uniformly grey. The eggs are laid on the apple or even on the strig, rarely on the leaves; they are flat, shiny, and transparent, looking like a drop of dew with beautifully sculptured shell and about the size of a small pin's head. The maggot enters the eye, where it feeds for a while on the skin; it then tunnels to the core, eats the pips, and later makes a larger tunnel to the exterior, through which it passes out its excrement. The maggot is creamy-grey to dusky-pink, and may reach ¾ in. in length; it has six jointed legs in front and four pairs of prolegs, and an anal pair. When full fed it either falls from the apple to the ground or crawls from the apple if it has fallen, and then reascends the trunk of the tree to any shelter, such as under rough bark, moss, and lichens, and there it spins a dull-grey or

brownish cocoon and remains as a maggot until the spring, when it changes to a pale-brown pupa. Now and again early matured maggots pupate at once and a second brood occurs. Some larvæ are still immature when the fruit is picked, and pupate in the storehouse. Foreign fruit, often picked before it is ripe, frequently contains the codling maggot, and these are



Codling Moth and Grub (*Carpocapsa pomonella*)

introduced from country to country with the barrels of fruit.

Treatment in orchards consists of banding the trees with loose sacking so as to catch the maggots, which spin up beneath it, and of spraying with arsenate of lead soon after the blossom has fallen; the poison lodging in the open eye is retained there, and so kills the maggots before they enter the fruit. Arsenate of lead wash is made as follows: Arsenate of soda (pure or crystalline), 3½ oz.; acetate of lead, 7 oz.; water, 10 gal. Both ingredients are dissolved in the water. It may also be obtained in a ready-made paste form (Swift's paste).

Poultry and pigs do much good in orchards as a means of checking this pest. Old orchards should be sprayed for two or three winters with caustic alkali wash or lime and salt wash to clean away winter shelter. The caustic alkali wash is made as follows: Caustic soda, 5 lb. (70 per cent); carbonate of potash (80 per cent), 5 lb.; soft soap, 2½ lb.; water, 50 gal. The soft soap should be dissolved separately in warm water and then added to the dissolved soda and potash.

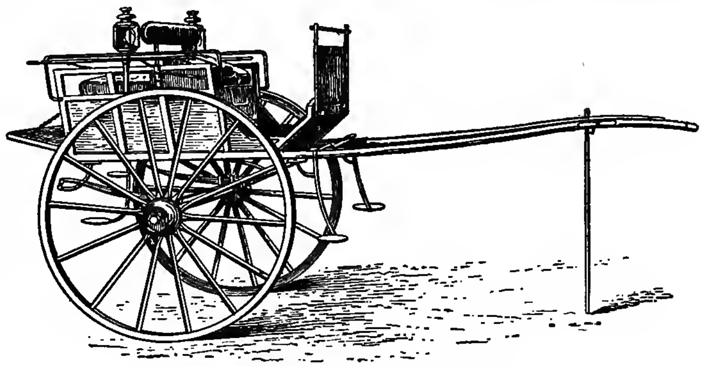
Lime and salt wash is made by slacking 1½ cwt. of best white lime and making it into 100 gal. of lime wash by adding water; to this add 30 lb. of salt. [F. V. T.]

Carriage, Carrier.—'A common carrier is one who undertakes for hire to transport from a place within the realm to a place either within it or outside, the goods of all who think fit to employ him in the business which he professes to ply.' A carrier is bound to carry such goods as he professes to carry, provided the goods are not of unreasonable weight or bulk, or of a dangerous character, and provided he has room for them. The liability of a carrier for the safety of the goods consigned to his care is at common law very onerous, for he is held to insure the safety of the goods and guarantee delivery of the articles which he accepts for carriage. The only defences open to a carrier at common law are: that the loss had happened (1) through an unforeseen accident which could not have been prevented by the exercise of any reasonable foresight; (2) by the act of the king's enemies, or (3) by the inherent vice, or tendency to take harm, of the article carried. In addition, however, the fault or contributory negligence of the consignor may relieve the carrier from any liability. In order to escape the severity of this rule, the custom sprang up of carriers posting notices disclaiming liability for goods above a certain value, unless such value was declared; and in order to place the matter on a definite and satisfactory footing, the Carriers Act of 1830 was passed, whereby it is enacted that common carriers by land shall not be liable for loss of or injury to gold or silver, plated articles, precious stones, jewellery, watches, clocks, trinkets, bills, notes, securities, stamps, maps, writings, glass, china, silk, furs, or lace, where the value exceeds £10, unless the value and nature of such articles have been declared and an increased charge paid or agreed to be paid. (For the law regarding damages for loss of animals during transit, see ANIMALS, CARRIAGE OF.) Apart from the provisions of the Act, no public notice limiting the carrier's liability is to have any effect; but a special contract may be entered into between the carrier and the customer, provided the contract is, in the opinion of the Court, just and reasonable, and is signed by the consignor or his agent. If, however, a company contracts to carry goods partly by rail and partly by sea, a condition freeing the company from liability for damage during the sea carriage occasioned by dangers of the sea is valid as part of the contract, if published in a conspicuous manner in the office where the through booking is effected, or legibly printed on the receipt or freight note. Where goods are carried partly over the lines of one company and

partly over the lines of another, the company which accepts the goods is, apart from special condition, liable for their safe delivery to their destination.

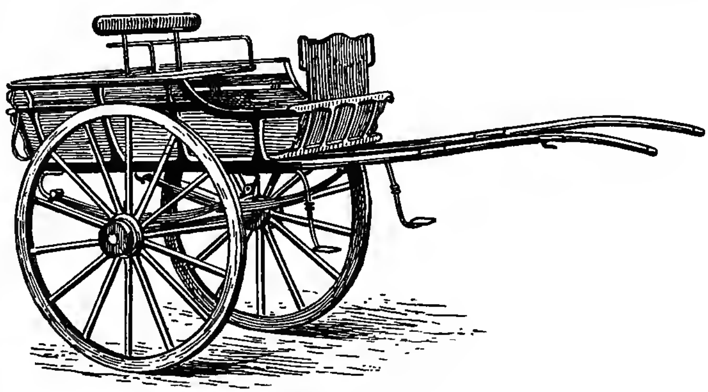
So far as regards the carriage of passengers, railway companies are not common carriers. Consequently they are not liable as insurers. In order to safeguard human life, however, a very slight degree of negligence is held to be sufficient to ground a claim for damages if injury has occurred. It is their duty to carry anyone who presents himself, provided they have room and the passenger is in a fit state to be carried. They are bound to take the passenger to the destination to which they contracted to carry him, and failing their doing so, he is entitled to charge them with the expenses of reaching his destination. They are bound to carry passengers within a reasonable time, but mostly all companies limit their responsibility by express notice in their time tables and otherwise. Even where the delay is undue, it does not follow that the passenger will be entitled to recover all damage which he may have suffered directly or indirectly through the late arrival of the conveyance. Thus it has been held that a passenger was not entitled to recover damages for illness contracted through having to walk home, nor would he be entitled to demand a special train merely to avoid a few hours' delay. As in the case of goods, a railway company issuing a through ticket is liable to the passenger whether the accident occur on its own line or that of another company over which he travels in the course of his journey, and, on the other hand, the company on whose line the accident has occurred may be sued by the injured passenger on the ground that the fact of the company carrying passengers imposes on it a responsibility for all injuries arising through their fault. [D. B.]

Carriages.—Carriages used for the conveyance of the farmer and his family vary considerably in character, and, like dress, are much ruled by individual taste and the position of the farmer. There have been estates where, in the palmy days of English farming, and where the holdings were large, it was a condition of entry that the farmer should hunt, and keep a carriage and pair. The dark days following 1879 removed bars of this nature, and though there are wealthy farmers who drive a pair or run a motor car, it is necessarily only those whose position is exceptional. Among the large holders of Lincolnshire, where some of them have farms lying far apart, and among those who combine trading in farm produce, especially potatoes, the motor car has been quite extensively adopted, as allowing them to make long journeys in a short time.



Farmer's Dog-cart (Bristol Wagon Works)

At quite small gatherings we have seen a dozen or more of motors of good power belonging to farmers; and the motor cycle is used by those of smaller means, though there is a tendency for those who have used motor bicycles to turn for greater safety and convenience to the motor car. The farmer ordinarily, however, is content with the more modest horse conveyance, and it meets his requirements. As there is a distinction between the farmer of 5000 ac. and 1000 ac., so



Jack's strong Chapel Cart

there is a distinction between the 1000-acre farmer and the 500-acre farmer, and between him and the 50-acre farmer, while intensity of cropping and the necessary capital per acre marks a distinction not indicated by acreage, and the carriage outfit varies greatly; hence it is impossible to say definitely that any one class of carriage is suitable to a farmer. The fact that a farmer lives somewhat an isolated life, and must travel more or less a considerable distance to market, railway, church or chapel, and for social entertainment, necessitates that

he shall have a vehicle to convey himself and family as occasion demands. A wide range, from a light, plain spring cart to a well-ordered phaeton or wagonette, or to a covered two-wheel 'sociable' or a brougham, is open to him, and is availed of. Whatever a farmer may choose for his more or less pretentious carriage, a light spring cart of good capacity is practically necessary for conveying light produce to and from market, or for getting about the farm, and this may take the shape of a dog-cart, plain spring cart, or the intermediate form known as a station cart. The latter is of stronger build than the dog-cart, and is capable of conveying travelling boxes, parcels, &c. Many keen farmers take round the cattle and sheep corn in their farm cart, and moreover use it to convey gangs of men from one job to another, and thus save much time, for a body of men left to shift themselves and take their accustomed gait do not often suggest in their movements a proper appreciation of the value of time; thus the farmer's cart may prove very useful, especially during the more busy seasons. The chapel cart, which is a light spring cart somewhat after the type of a good station cart, is a roomy vehicle well suited to the conveyance of the family; it combines comfort with utility, and is used by those who relatively in the same position would use a dog-cart. The farmer's gig has fallen out of the favour it once held, possibly because with greater facilities for railway travelling there is not so often the need for a light running trap to convey only one or two, and one suitable to carry a larger number in emergency is preferred. [W. J. M.]

Carrier Pigeon.—The Carrier Pigeon is not so named on account of any capacity for carrying messages. The bird used for this purpose, though frequently miscalled 'carrier', is properly named the 'homing pigeon'. The true Carrier Pigeon is, indeed, very ill-formed for flying at all, as the large development of the wattle round the eye greatly interferes with the sight. There is no record that the carrier has ever been used for homing purposes; and if it ever has, it is certainly not within the last century.

Nothing is more difficult than to obtain a perfect specimen of the carrier breed. The points are so numerous and diverse that they are rarely found all perfect in combination in any one bird; and when this combination does occur, the bird is of great value. Owing to the highly artificial environment in which they are usually kept, they are very bad feeders of their young, and it is generally necessary to provide pigeons of the stronger varieties as foster-parents for the young carriers from the second week of their existence.

The following is a general description of the standard for the English Carrier Pigeon. The head should be long, straight, narrow, and flat at the top. The beak should be long, straight, and thick, its colour being flesh-colour, interspersed in the case of Blacks and Blues with black streaks. The beak-wattle on the upper mandible should be distinct from the eye-wattle, soft, broad, and pointed at its end towards the tip of the beak. The size of the upper and lower wattles together should be the greatest possible. The eye-wattle should be large, circular, and fleshy, the eyeball being prominent, and the iris fiery red in Blacks and Blues. The neck should be long and thin. The back should be straight and sloping, the breast full and deep, shoulders muscular, wings strong, the tail long and running in a sloping line with the back, and carried clear of the ground. The thighs and legs should be muscular, and the toes large and well spread. The length from the tip of the beak to the end of the tail should be about 17½ in. The black birds should be of a raven lustre, the duns may be of various shades; and there are in addition the blues, whites, and various coloured pieds. The feathers should be dense and closely set. This description applies to a cock about three years of age, and the requisite modifications must of course be made in the case of hens, or birds of different ages.

[H. S. R. E.]

Carrot.—The wild carrot (*Daucus Carota*, L.), which belongs to the nat. ord. Umbelliferæ, is a native plant common in pastures and by roadsides, more especially on light land, where it is a weed. It is of annual duration as a rule, and has an elongated, woody taproot. The hairy stems are branched, erect, and furrowed, with much-divided leaves. The umbel bears many white flowers, on branches which when ripe curve inwards to form a cup-like structure somewhat like a miniature bird's-nest: the central flower is often purple. The fruit consists of two carpels, on which are four secondary ridges bearing rows of soft spiny projections, a few smaller ones being also present on the five primary ridges.

The cultivated carrots, of which there are a number of varieties, very closely resemble the wild carrot in form and character of their stems, leaves, flowers, and fruits; they have without doubt been derived from the wild species by selection. The only marked differences between the wild species and cultivated varieties are in the duration of the plants—the wild one being generally an annual and the cultivated type biennial—and in the fleshiness of the root, which is greatly increased in the farm and garden forms.

In the early part of last century M. Vilmorin (Paris) produced fairly good garden types of carrot with fleshy roots and biennial habit from the wild species. Seeds of the wild carrot were sown somewhat late, about May or June, and selections were made of a few roots which did not flower in the first season. The seeds from these produced plants, a greater proportion of which had lost their annual character and did not flower until the second season. The largest and best-formed roots of these were again selected and allowed to seed. The plants from this seed again showed improved habit and form. By continuing the selection of non-flowering roots with fleshy thickening, M. Vilmorin obtained in four generations a number of varieties with thick roots, some with white, others with yellow or red flesh, all of which showed little tendency to 'bolt' in the first season.

The presence of spiny projections on the

'seeds' of carrots renders them liable to cling together and difficult to sow unless first mixed with dry earth or ashes, or rubbed to get rid of the spines. The young seedlings possess two long narrow cotyledons and are easily smothered by weeds. A great many varieties of carrot are known, varying in form and length of root, colour of flesh, and size of core. In some the flesh is white, in others yellow, orange red, or violet.

The following are the chief varieties grown on farms:—

1. *Belgian White*—a form with very thick roots, which have white flesh. The upper part is greenish, and grows about 6 in. above ground. *Wiltshire Giant* is similar to this. Both are hardy and very productive. *Yellow Belgian* varieties are known. They yield less per acre than the white sorts.

2. *Long Red Surrey*—a variety with very long, tapering roots, deep-red flesh, and small yellow core: more adapted for gardens than for farm purposes.

3. *Red Intermediate* and *Yellow Intermediate* are sorts with very thick roots of medium length. Some of them are grown extensively in market gardens as well as on farms.

4. *Altrincham*—an old field variety with long thick roots, which are bluntish at the end. It has a greenish-purple top and pale-reddish-orange flesh, and grows partly out of the soil.

[J. P.]

In offering a few remarks upon the cultivation of the carrot as a food for live stock, it may be remarked that it has always been a favourite with horse-keepers as a sweet and agreeable food much liked by horses, and considered to give brightness to their coats. It is greatly relished by pigs, and, like parsnips, it possesses superior feeding properties. The heavier-yielding varieties may be used for fattening cattle, but they are too deeply embedded in the soil for sheep, neither are they suitable for these animals. Their sweetness, although a point in their favour, may become an objection, as they are liable to make animals 'sweet-mouthed', and to cause them to discard plainer fare. Carrots, therefore, appear to be especially suitable for horses and pigs, and for these animals they are very highly esteemed. In market gardens and on suburban farms they may be profitably grown; but on wide-lying farms their cultivation is very restricted, although an acre or two of carrots may be grown with advantage near the homestead for the purposes already mentioned. The depth of the roots renders the crop expensive to secure, and also points to the advisability of growing them upon deep soils free from stones. Shallow and stony ground are useless for the purpose, as they not only check the downward passage of the taproots, but cause them to divide and produce fangs. Deep clays are not unsuitable, and the writer has known 30 tons per acre of white Belgian carrots produced upon such soils. The best land for the purpose is deep and sandy, and free from stones; such as is found in Bedfordshire around Biggleswade, and on alluvial tracts in other counties.

The carrot is both deep-rooted and scantily furnished with top, so that the leaves give little assistance to the lifters at the time of storing. The puny character of the leaves also renders the young plants rather difficult to trace in row on their first appearance; and these two peculiarities are answerable for certain precautions in carrot cultivation, as will be presently seen. Another feature of some importance is the clinging nature of carrot seed, which makes it difficult to drill. As in all umbels, the seed consists of a disk furnished with transverse glands, well seen in parsnip seed. In carrot seed the disks are furnished with small bristles around the margin, which cause the seeds to adhere to each other. The consequence is that it is necessary to submit carrot seed to an operation by which the bristles are removed, and most of the seed now offered has been so treated. If the seed has not been thus prepared, it is necessary to mix it with a considerable bulk of moist sand or the like in order to ensure separation and distribution. Two bushels of sand well mixed with 2 to 4 lb. of seed will suffice for an acre. The puny appearance of the young plants when they appear above ground also renders it advisable to intermix a few pints of barley or oats, so as to mark the row after germination takes place.

Turning to the preparation of the soil, the deep-searching character of the root prescribes deep cultivation, and the nature of the seed requires a finely harrowed and rolled surface. The seed must be deposited at not more than $\frac{1}{2}$ in. in depth, so that thorough and deep cultivation should be accompanied with a fine and uniform surface. In drilling, the weights are removed from the drill coulters, and care is taken to see that the flow of seed is regular. The site having been fixed upon, the land should be ploughed as deeply as possible, and, if subsoiling is practicable, it may be adopted. A furrow of 10 or 12 in. in depth is not impossible upon sandy soils, but the best advice is to plough as deeply as possible. A dressing of short or rotted dung ought to be in the first place spread over the surface and ploughed in. These operations are best performed in autumn, in order to induce thorough pulverization of the surface. A cross-ploughing in the winter is often advisable, but it is important to secure and maintain a finely weathered and tender surface. Late spring ploughing is therefore to be avoided, and the cultivator or grubber may be substituted for the plough previous to drilling. This is followed by dressing with the harrows, and finally with rolling. The object to be aimed at is a deep, well-pulverized, and fine seed-bed, topped with a level and smooth surface.

Drilling is carried out with the precautions already mentioned, and the best season is the latter end of March or the first week of April. The carrot is comparatively hardy, and being usually grown in sheltered situations it may be sown earlier than most root crops. The distance between the rows usually recommended is from 9 to 12 in. In southern England carrots are generally drilled 'on the flat', but in the north, where the raised ridge system prevails, they are drilled in twin rows 5 in. apart by a special

machine, on the top of ridges 28 in. apart. The character of the plant is suitable for this system, as interculture is easier, and may be commenced sooner between ridges than on the flat. The horse-hoe, also, may be used even before the plants appear, as the drill lines are on the tops of the ridges. Long before the young plants can be traced they may be horse-hoed on the ridge; but owing to the drier climate of the south, raised ridges have never been popular.

One of the principal difficulties in carrot cultivation is the thorough weeding of the ground. Soon after the seed is sown the surface becomes covered with annual seedlings, which often bear a striking resemblance to the young plants of the future crop. The carrot is slow in germinating, and is not clearly discernible in its early stages. The greatest care is therefore necessary to secure *clean land*, but the prevalence of small annual weeds on even the best-managed farms entails rigorous hoeing, and even hand-weeding. Chickweed, stoneweed, wild spinach, speedwell, &c., are liable to smother a small seedling like the carrot, especially when drilled on the flat; and hence the labour is more expensive than in the case of broader leaved and conspicuous plants. Hand-weeding in the rows, and Dutch hoeing between them, are the means usually employed. Under such circumstances it is not surprising that carrot cultivation should be restricted to small areas.

Carrots respond to the usual artificial dressings, and are much benefited by the application of superphosphate and potash salts. These may be applied at the rate of 3 or 4 cwt. of the former, and 1 or 2 cwt. of the latter; and 2 cwt. of nitrate of soda given in successive topdressings will greatly increase their effect. When once well started, the critical period is past.

We now pass on to singling, which is often done by hand, the roots being left 3 to 5 in. apart. The width to which the plants are singled is regulated by the objects of the cultivation; for young carrots tied in bundles sell well, and drawing may be regulated by this fact. Neither is it necessary to draw surplus plants by hand, for singling may be performed by means of a short-bladed hoe of about 3 in. in width. The Dutch or push hoe is useful between the rows, and hand-hoeing is to be preferred to horse-hoeing in the narrow spaces usually employed. On the other hand, when the carrots are grown in ridges in twin rows, horse-hoeing, and even earthing up with the plough, may be practised.

Carrots may be grown in combination with mangel-wurzel, *i.e.* a row of carrots and a row of mangel alternately, and the wide spaces between the drills of mangel are conducive to a heavy yield per acre. The carrots do well between the mangel rows, and the united result is satisfactory.

The lifting and storing of the crop is the next point of importance, and this usually takes place in October or early November. The growing carrot is not easily injured by frost, as it is safely buried in the soil, but ought not to be moved during frost. The best method is to loosen the soil with a three- or four-pronged digging-fork and to draw the carrot out by its top. Two men work together, and while one loosens the soil the other draws out the root and cuts off the leaves near the crown. Dry and mild weather is most suitable for the work, and the roots are then collected and built up into narrow clamps 2½ to 3 ft. wide, with the crowns lying outwards, and the tails towards the centre of the prism-shaped long heap. They are then covered with straw, upon which 5 or 6 in. deep of loose soil is placed, leaving a ridge of a few inches wide vacant along the apex. The heap should then be thatched, and the straw brought up to a point so as to protect the portion not covered with soil. This secures ventilation and prevents heating, which may be a cause of rotting and collapse. Carrots so stored, and especially if not put together wet (or frosted, which is fatal), will keep well through the winter. They ought to be carefully cleaned from rootlets and adhering earth before they are given to stock of any sort.

Cost of Production and Value of the Crop.—Carrots are expensive to cultivate on account of the difficulty in lifting, which operation has been estimated at various amounts, according to the weight of the crop. Ewart, who was a most painstaking investigator of costs, gives the labour of pulling, topping, and filling into carts as equivalent to 7·2 days per acre for an able-bodied man for a 12-ton crop. This at 2*s.* 6*d.* per day is equal to 18*s.* per acre or 1*s.* 6*d.* per ton. The cost must vary considerably, although a 24-ton crop would not cost twice as much as in Ewart's example. Probably the entire cost of lifting, storing, and covering will vary from 25*s.* to 35*s.* per acre. The exceptional character of the land, and the liberality of the dressings required, added to the cost of storing, render carrot cultivation much more expensive than that of ordinary root crops. Estimates of costs can only be approximate, but the following could not be seriously cut down:—

	£	s.	d.
Labour of dunging	0	10	0
Deep-ploughing	0	12	0
Spring cultivation	0	7	6
Drilling	0	1	6
Weeding, push-hoeing, and singling	1	0	0
Superphosphate and nitrate of soda	1	5	0
Seed	0	5	0
Hoeing and weeding (interculture)	0	15	0
Storing	1	10	0
Rent, rates, and taxes	2	0	0
	£8	6	0 per acre.

If cleaning the land previous to applying the dung is added, the total cost will approach £10 per acre.

The value of the crop depends upon the weight produced, but 20 tons per acre would evidently cost 10*s.* per ton. As to the value of the produce it may easily reach 20*s.* per ton, but much depends on whether the crop is sold or reserved for home consumption. Carrots are superior to swedes for feeding purposes, in so far as they contain less water, and a small pro-

portion of oil. They are also richer in sugar, and the carbohydrates are given as 11 per cent against 7·1 per cent in swedes. The conclusion appears to be that carrots are a valuable food, and deserve a position among the minor crops on a large farm. On the other hand, their cultivation is too expensive, and their yield too uncertain, for extensive cultivation. [J. WR.]

Carrot, Insect Enemies of.—These include the root fly (see PSILA ROSÆ) and various species of blossom moths (see DEPRESSARIA). Like other root crops, carrots are also subject to the attack of wireworms.

Carrot.—Parasitic Fungi.—The most frequent disease of this crop is a root disease, caused by *Phoma sanguinolenta*. This may be recognized on the carrot tubers as greyish-brown sunken spots, which become studded with minute dark dots, the conidia cases; the conidia are carried out of the case on a short curly cord, which from its red colour has suggested the species name given above. If the roots are used for seed production, the mycelium in them extends into the flowering stem and causes this to die before seed is matured, and in this way may bring about considerable loss. Damaged roots should not therefore be used for seed purposes, and as this rot spreads amongst stored carrots, it is best not to keep any that are damaged. Other species of Phoma cause damage to swedes, and to beet and mangels.

The foliage has sometimes been observed to be attacked by a rust (*Puccinia bullata*), which also occurs on celery and other species of Umbelliferæ. *Plasmopara nivea*, a downy mildew, has also been recorded.

Treatment. — Bordeaux mixture applied by spraying will keep the foliage pests in check. Rotation of crops is necessary to keep these and the root rots from spreading. If the crop is to be stored, it ought to be sorted out, all damaged roots being used at once or destroyed. [W. G. S.]

Carrucate, Carucate, a term formerly employed to denote the acreage of land which could be tilled by a single plough in one season, a quantity that varied considerably in area according to circumstances.

Carse, a word of uncertain origin, but probably originally the plural of 'carr', a wet lowland. From being applied to a damp alluvial area, it became associated with fertility, and 'carse-lands' in Scotland denote certain rich alluvial lands spreading from the margins of rivers to the valley-sides (see art. ALLUVIUM). [G. A. J. C.]

Carse-Land Farming. See FARMING, SYSTEMS OF.

Cart Horse.—The cart or draught horse, by reason of the work he has to perform, must necessarily be a strong and weighty animal. Although there are a number of varieties of so-called draught horses, such as the Suffolk Punch, Percheron, and Belgian Draught Horse, by far the most common and specialized breeds are the Clydesdale and the Shire. These latter varieties have for generations been selected and bred, with the result that at the present time they undoubtedly furnish the most popular, widely distributed, and typical draught horses of the world. The conformation of the cart horse is of great importance, and while he must be possessed of a deep, powerful body, he must at the same time have limbs of sufficient strength and quality to stand the daily strain of severe toil and support his bulky frame. The entire make-up of the draught horse should suggest strength for heavy haulage. He should be broad, deep, thick, round, with each part in keeping with its neighbouring parts, giving an appearance of symmetry and massiveness. He should be low down, blocky and compact on strong-boned, clean legs, showing marked prominence and development of tendons, and the legs should be properly placed and set to ensure correct straight action at the walk and trot. The term 'quality' when applied to a cart horse denotes evident refinement in character of skin, muscle, bone, tendons, and hair. It also implies aristocratic breeding and all the attributes of pure blood.

In a well-bred cart horse the head should not be unduly large—the forehead broad and the eyes intelligent, the ears small and close together, whilst arched or 'Roman noses' are characteristic of the Shire breed. The neck should be arched and powerful, but not too long; the shoulder well laid on and oblique; the body compact, with short and powerful loins; the barrel deep and well rounded, and ribbed close up to the flank; while the thighs cannot be too muscular and strong. The joints, especially the knees and hocks, should be large and well developed, for they act in the capacity of levers, and if small and fine, indicate weakness; the forearm and second thighs should be muscular, and below the knees and hocks the cannon bones should be well developed, short, and flat; whilst the class of hair or feather that is to be desired on the limbs is of a fine, straight, silky texture; the pastern oblique and sloping, and the foot large and well moulded, without any undue tendency to flatness of sole. The prevailing colours of the cart horse are bay, brown, and black, although quite a number of greys are to be met with among the Shires and Percherons.

In the Clydesdale breed of late years there has been a marked tendency to produce animals with white markings on the limbs and face; and while in moderation this undoubtedly adds to their appearance, if overdone it tends to give an impression of washiness and softness of constitution. Chestnuts are rare, and there is a marked antipathy amongst breeders to use stallions of any but the recognized colours. In height the draught horse varies from 16·1 hands to 17·1 hands, and a good-sized specimen of a heavy draught gelding when in condition may scale over a ton.

The action of the cart horse is also a matter of importance, especially at the walk, for this is the pace at which he has to perform his work, and a smart, even walker that can flex his knees and hocks and cover the ground at four miles an hour is a useful animal. Particular attention has for many years been given by

breeders of Clydesdales to developing this quick, elastic, energetic walk, and this breed is now noted throughout the world for their long, free, springy action, which, when work has to be done upon heavy land, is a great advantage. In walking, the joints must be easily and fully flexed, the feet must advance and be set down without deviation from a straight line. The soles of the feet should turn up and show plainly to the judge as the horse goes from him at both walk and trot; the feet should be lifted quickly, fully, and rhythmically, and set down squarely and firmly. There should be no paddling, dishing, swimming, or interfering, nor should the fore legs roll or the hind legs be carried too close together or too far apart, the latter being a specially objectionable feature, as with age and hard work it tends to become aggravated. A rolling gait in front may be due to too great width of chest. Stubby, stilty action in front indicates straight or too upright pasterns or shoulders, foot trouble, or weak knees. The cart horse should have a natural good carriage of head and neck, for the horse that carries his head low is prone to stumble. It is not so important that at the faster pace (*i.e.* trot) the draught horse should show great action, but it generally follows that an animal that walks well also trots well.

There can be little doubt that as a class the Shire horse is unsurpassed for size, weight, and conformation of body, and probably, if it came to a trial of strength, can more than hold his own with any other variety of draught horse; but usually there is a coarseness of limb, a roundness of bone, and a want of obliquity about the pasterns which by many is not regarded with favour, the profuse growth of coarse hair on the limbs being said to indicate a tendency towards skin eruptions such as grease, while the more upright pasterns favour the development of ringbones and sidebones by increasing the effects of concussion. On the other hand, while the Clydesdale is possessed of finer bones in the limbs, longer and more oblique pasterns, and fine silky hair, it is a recognized fact that for weight of body and strength of coupling he is inferior to the Shire; hence it has long been held that for a general utility horse the cross between the two breeds should be unsurpassed, and the result of experience tends to corroborate this view. With judicious selection and mating of the Clydesdale stallion and the Shire mare, it is possible to produce an animal combining the massive body of the Shire with the quality of limbs and hair so typical of the Clydesdale, and in all respects the ideal draught horse. But while these crossbred animals are so suitable for work, they do not, as a rule, prove successful for breeding purposes, owing to the admixture of two distinct strains of blood, and consequent liability to reversion. [J. R. M'C.]

Carts.—Carts used for heavy work on the farm vary very much in accordance with local views, which took their origin at a time when the carts were made almost exclusively by village wheelwrights. As a rule these were clumsily made, especially in districts where wagons were used to perform most of the farm haulage. Since large firms have bestowed attention to the work, far better principles have been applied, and now well-constructed carts can be met with in most districts. Undoubtedly a great stimulus to improvement was given by the competition for prizes at the Bedford Show of the Royal Agricultural Society in 1874, when Messrs. Ball, who were very successful competitors, and other large firms competed, and

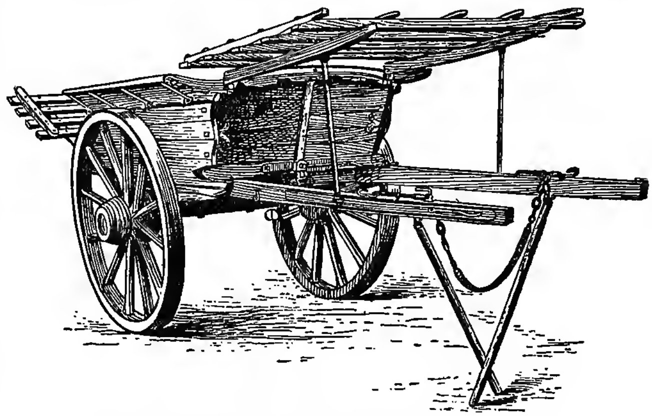


Fig. 1.—Ball's Farm Cart, fitted with removable hay-ladders

showed types which were better suited to farm purposes than were those to which visitors were accustomed. From that time local types have greatly decreased in popularity, although occasionally districts are found where the change has not been so marked. Naturally in hilly districts a smaller cart is preferred to the larger, owing to the difficulties of draught. A good general-purpose cart (Ball's R.A.S.E. first prize) is shown in fig. 1, which is equally suitable to haul hay or corn crops, or for carting out manure or other heavy material. The "ladders" are removable, the balance with or without the ladders is good, the tipping is simple and not likely to wear and get too much play—a dangerous feature in some forms engaging the body with the shafts—the wheels are strong and conveniently dished to afford easy running and a square bearing on the road, and the height is suited to the ready loading or unloading of sacks. Vertical "raves" or frames can be fitted on the ends of the ladders (fig. 2), and if tie-rods are made from one to the other, a safe and suitable frame for holding hay as pitched by a mechanical hay loader is provided. Ordinarily a wheel for a farm cart with a ring tire 3 in. by $\frac{5}{8}$ in. should carry 1 ton; with $3\frac{1}{2}$ in. by $\frac{5}{8}$ in., $1\frac{1}{2}$ ton; 4 in. by $\frac{5}{8}$ in., 2 tons, over

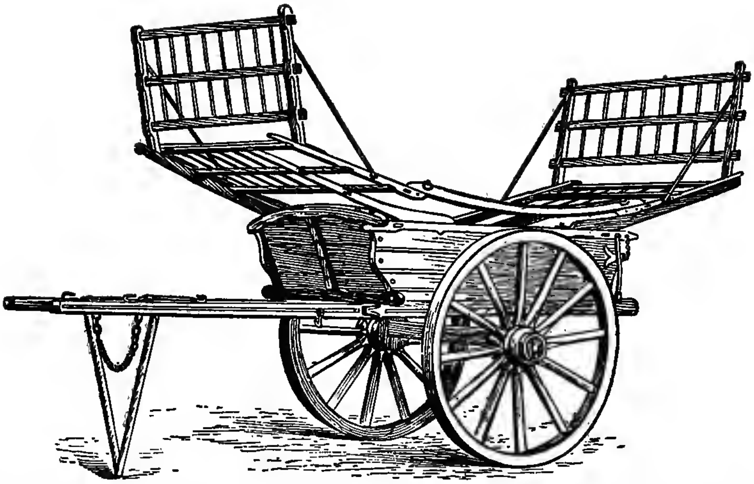


Fig. 2.—Ball's Farm Cart, fitted with front and back vertical ladders, with tie rods suitable to work elevator hay-loader

rough ground for many years. Much of the value lies in quality and thorough seasoning of the wood used in construction, and carts of badly seasoned wood rarely prove satisfactory.

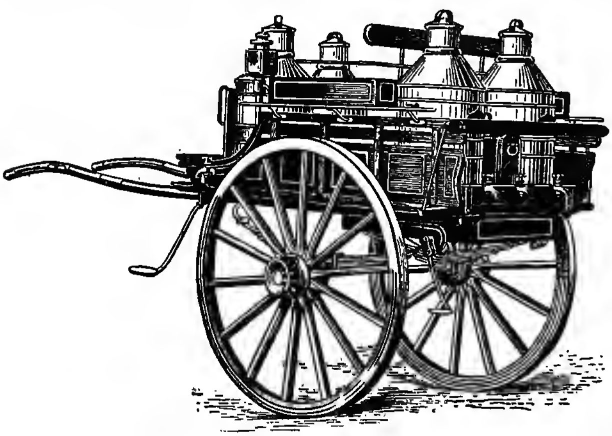


Fig. 3.—Jack's Milk Cart

In some districts, carts with skeleton bodies are used for hay and corn harvesting, with or without front or back ladders. When used without, they hold but small loads: when used with ladders, they are generally constructed so that but a small portion of the load is over the horse's back; consequently, if a long-bodied cart is used, the balance of the load is badly kept. Moreover, they are not types of general-purpose carts, and as such are less efficient than are those which meet all a farmer's requirements.

In the seed-growing districts, specially constructed carts are used to convey turnip seed and similar crops. These are long-bodied carts, made with closely-boarded sides and bottoms to prevent the escape of seed, which threshes out very readily when loaded. They are mounted on low wheels, and the sides are hinged to expedite the unloading; as the load is necessarily a light one, the matter of

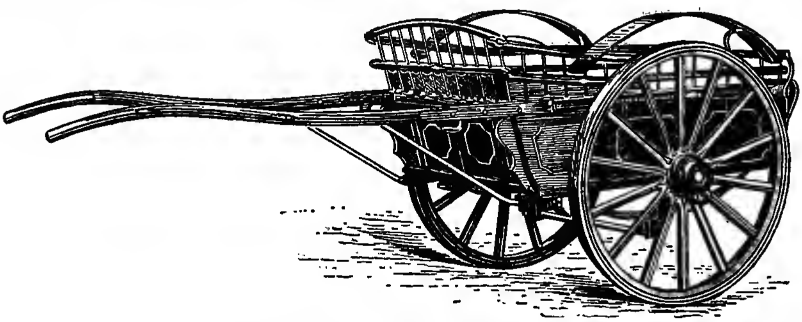


Fig. 4.—Ball's Float for Milk and General Purposes

balance is not so important as in the circumstances just alluded to.

Milk carts are usually made with bent axles to allow a low body, to facilitate the loading of

heavy cans, and good springs are necessary to prevent undue shaking. Light floats, or low-bodied carts, are convenient for carrying heavy materials to distant stations; these are generally somewhat long in the body, and mounted on strong springs. The cattle cart or bull float is more generally employed by cattle dealers, though breeders of exhibition stock find them convenient for conveying valuable and heavily fed cattle to the station.

The farmer's spring cart (see CARRIAGES) is ordinarily used for conveyance to market or

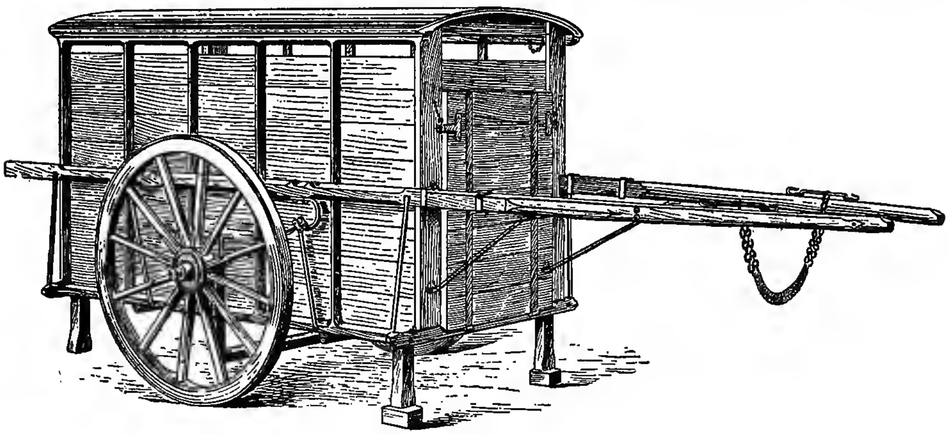


Fig. 5.—Ball's Patent Two-wheel Cattle Cart or Van

for driving about the farm. The position or pretensions of the farmer largely directs the nature of this vehicle. [W. J. M.]

Cartridges. — Cartridges consist of four main parts—powder, shot, wadding, and cartridge case; and it will be necessary to consider each of these parts separately. There is a great difference also between cartridges for shot-guns and cartridges for rifles. In shot-gun cartridges the *powder* used almost exclusively is smokeless powder. Except for very hot climates, black powder has fallen into general disuse. The active agent in all smokeless powders is nitric acid. Cartridges with smokeless powder may be kept for an indefinite period without deterioration, if they are in a dry atmosphere and within moderate degrees of temperature. They give better results if placed in a warm room (about 60° F.) for a few hours before use. *Shot* is made in sizes ranging from 40 to 1000 pellets to the ounce, according to the size of the game for which it is to be used. The size in most general use for sporting purposes in England is No. 6, which contains 270 pellets to the ounce. The best kind of shot, called 'chilled shot', consists of an alloy of lead, and is made in the following manner. A large plate, perforated with circular holes of the size of the shot required, is fixed at the top of a tower, and at the bottom of the tower is a tank of water. The molten metal, being poured upon the perforated plate, falls in drops through the holes, and solidifies while falling, before reaching the water at the bottom. The 'chilled shot' thus produced is much harder, and consequently much better, than shot made of pure lead. The *wadding* generally used in a 12-bore gun consists of a card wad next the powder, and in contact with this on the outer side a soft felt wad nearly ½ in. thick. Next this comes the shot, and on the outer side of the shot another wad strong enough to keep the pellets from shaking loose. *Cartridge cases* are made of brass or paper. The former have the advantage of being impervious to wet, but there are now many waterproof paper cartridges made.

For rifles, *smokeless powder* is generally used, as in shot-guns. The best forms of smokeless powder are the 'concentrated powders', such as cordite and ballistite, which consist either of gun-cotton almost entirely, or else of gun-cotton mixed with nitro-glycerine. The *projectiles* are made in a great variety of ways, and there is much difference of opinion as to what is best. They are either solid or hollow; the object in the former case being to secure as deep penetration as possible, and in the latter case to cause a bad wound by the expansion of the bullet as soon as it strikes. *Wadding* is also made in various ways. Frequently a soft felt wad saturated with grease is used, the powder being protected from this by the interposition of a second grease-proof wad. In some bullets, such as the ·303 Lee-Metford, no wadding whatever is used, the base of the projectile itself serving the purpose. The *cartridge cases* are made of brass and solid drawn. [H. S. R. E.]

Caryophyllaceæ.—This is the name for the nat. ord. of dicotyledonous plants which includes pinks and carnations, chickweeds, &c.

A Caryophyllaceous plant is distinguished (1) by the petals being distinct; (2) by the stamens situated beneath the ovary, and twice as many as the petals; and (3) by the opposite simple leaves. In number the sepals of the regular flower are five, the petals are five, the stamens are twice five, and the carpels either five, or reduced to four, three, or two. The ovary is in the inside of the flower, and contains in its single chamber a large number of ovules seated

on a free central rod. The styles on the top of the ovary are not grown together, but perfectly distinct. When the ovary is ripe it forms a dry seed-box, which opens and allows the numerous seeds to escape. The seeds are kidney-shaped, with the skin covered by concentric rows of dots. If the seed is cut it is seen to contain on its concave side a snow-white floury substance, and on its convex side a curved embryo. The white meal in the seed is used for nursing the baby plant during the period of germination.

The flowers in this order are always in clusters, with the oldest flower in the centre, and from the stalk of this a pair of younger flowers spring forth. The side flower may in turn become a central flower and a parent for another pair of still younger flowers, and so the number of flowers per cluster becomes increased.

The plants are annual or perennial herbs, often pestilent weeds, for example the annual chickweeds on arable land, and the campions on grassland. The leaves spring in pairs from the swollen nodes of the stem, and are always simple and entire without lobes, very narrow and linear on those kinds adapted for growth on poor sandy land, such as mouse-ear chickweed, but becoming broader as the land becomes richer and moister, as in common chickweed and campions.

The important weeds of the order may be arranged thus:—

1. *Sepals grown together.*—Mouse-ear chickweed (*Cerastium*), a white-flowered annual in fields; Corn-cockle (*Lychnis Githago*), a purple-flowered annual weed in corn; Red Campion (*Lychnis diurna*), a red-flowered perennial of pastures; White Campion (*Lychnis vespertina*), a white-flowered perennial of moist pastures.

2. *Sepals not grown together.*—Common chickweed (*Stellaria media*), a hairy white-flowered annual of rich land. [A. N. M'A.]

Case-bearers. See Coleophoridæ.

Casein is the principal proteid in the milk of mammals, and it is the characteristic component of cheese. Besides casein, milk contains small quantities of two other proteids, namely lactalbumen and lactoglobulin. A fourth is also stated to be present, but its existence needs further confirmation.

Casein forms about 80 per cent of the total proteid matter in milk. It can be prepared by diluting fresh milk with about five times its own volume of water, then adding acetic acid until the strength of the solution reaches about ·1 per cent. The casein is precipitated, carrying most of the fat down with it. The precipitate is washed with water several times by decantation to remove as much of the soluble bodies present as possible. It is afterwards collected on cloth, and most of the water squeezed out by pressure. Ammonia in which the casein dissolves is then added to the precipitate, and on standing the fat rises to the surface. The clear ammoniacal solution is syphoned off from the layer of fat, and the above process repeated several times to remove as much of the fat as possible. The precipitate finally obtained is rubbed up with alcohol, placed in a socket apparatus, and the fat extracted with ether. The casein obtained is then dried *in vacuo* over strong sulphuric acid. Prepared in this way casein is a white amorphous powder, without taste or smell, insoluble in water, alcohol, and ether. It is with difficulty obtained free from mineral substances.

Its percentage composition may be stated as follows:—

	Per cent.		Per cent.
Carbon	53·13	Sulphur	0·77
Hydrogen ...	7·06	Phosphorus ...	0·86
Nitrogen	15·78	Oxygen	22·40

The following table taken from Richmond's Dairy Chemistry gives the percentage composition of casein as determined by different authorities:—

	Hammarsten.	Chittenden.	Stohman.	Lehmann.	Ritthausen.
	per cent.	per cent.	per cent.	per cent.	per cent.
Carbon	52·96	53·30	54·08	54·00	54·22
Hydrogen ...	7·05	7·07	·7·09	7·04	7·17
Nitrogen	15·65	15·91	15·57	15·60	15·49
Sulphur	0·72	0·82	0·77	0·77	0·91
Phosphorus ...	0·85	0·87	—	0·85	—
Oxygen	22·78	22·03	—	21·70	—

Casein possesses acid and basic properties. Söldner has shown that casein forms two compounds with lime: one contains 1·55 per cent of CaO, and the other 2·39 per cent; these correspond with CaO and 2CaO combined respectively with one molecule of casein. Solutions of alkalis and alkaline salts dissolve casein, and from which it can be reprecipitated unchanged by the addition of sufficient acid to neutralize the alkali. Casein in solution gives a lævorotatory action to polarized light. Strong acids dissolve and hydrolyse it, the products of hydrolysis being amido compounds. A solution of casein in acetic acid has been used as glue.

The exact form in which casein exists in milk has not been satisfactorily settled. Solutions of some salts and acids, when within certain strengths, cause casein to disintegrate and form an opaque solution, whilst outside those strengths casein remains firm and hard in presence of the same reagents. Little is known, however, as to what extent, if any, casein may exist in milk in a colloidal or suspended form. The effect of varying strengths of different salt solutions upon the texture and water-holding capacity of the curd becomes in consequence a factor of importance in the manipulation of the curd for the manufacture of cheese. This problem has not, however, been much investigated. The greater part of the casein appears to exist in solution in

CAMEL AND BUFFALO YOKED TOGETHER, WORKING AN EGYPTIAN STRAW-CUTTER

CASHMERE GOAT

milk, in combination with calcium or some other base, as a soluble compound. On the addition of an acid to milk, the base forms a salt with the acid and liberates the free casein, which precipitates out. Casein can be separated from milk by most of the reagents employed in precipitating proteids.

In the preparation of casein from milk for the manufacture of cheese, two methods are adopted:

1. The addition of acids.
2. The addition of rennet.

No. 1 method is the process that goes on in the natural curdling of milk. Where milk is exposed to air, the milk sugar under suitable conditions is converted into lactic acid by the micro-organism *Bacterium lactis.* The acid thus formed precipitates the casein unchanged, forming a curd. Most acids will produce this result.

No. 2 method is the one more generally employed in the process of cheese-making. The rennet used is extracted from the fourth stomach of a calf. The active substance in the rennet is an enzyme called chymosin. This splits up the casein into two proteids, one of which combines with any calcium salts present, forming a compound insoluble in water. It thus separates out as a curd. The other proteid remains in solution and goes into the whey. In absence of sufficient calcium salts no curd is obtained with rennet. 41° C. is the best temperature to add the rennet.

Casein is a very nutritious substance, and forms a valuable article of diet. Besides being the principal component of cheese, it is used in making biscuits, &c., also as casein gum or lacterin, as casein ivory or lactite, and in many other ways it is a valuable commercial product. [R. A. B.]

Cashmere Goat, The. — This breed, known also as the Tibet goat, is believed by naturalists to be descended from the same wild stock as the Angora, *i.e. Capra Falconeri*, although it presents a very different appearance to the mohair goat. The Cashmere is a small-sized breed, with long, straight hair, generally white, though specimens are met with of various colours; the horns grow upright, taking a spiral inclination in the male and sometimes crossing at the extremities. The head is small, the facial line being straight; the ears semi-pendulous and rather long, the neck and legs are slender, and the back broad with well-sprung ribs. This breed is very rare in England, only two herds being known to exist there at the present time. One of these is the royal herd at Windsor, and the other a small collection of some twenty head, the property of C. J. H. Tower, Esq., of Weald Hall, Essex, whose grandfather was the original importer of the Cashmere into this country in 1823. From this importation, some five years later, a pair was sent as a present to King George IV, these being the progenitors of the existing herd which roams in a semi-wild state in Windsor Park. In 1889, by which time the royal stock had greatly deteriorated through inbreeding, a few fresh specimens were consigned to the late queen by a regiment stationed in the Punjab, to the north of which district, in an elevated valley of the Himalaya Mountains, this breed has its home.

The Cashmere is sometimes referred to as the 'Shawl goat', on account of the fine downy fleece which grows at the roots of the hair, supplying the material for the famous Indian shawls, so many of which used to be given as wedding presents by the late queen. In the early Victorian era, when these shawls were in fashion, a very large industry was carried on in their manufacture, as many as 30,000 being reported to have been produced in India annually. Considering that the yearly yield of fleece from an average specimen of the Shawl goat varies from 4 oz. to 6 oz., anyone who has handled one of the royal shawls, and has realized its immense size and excessive weight, may form some idea of the enormous number of animals that must have been required to supply the material for the 16,000 looms which are stated to have been in constant work in this manufacture.

An imitation shawl of this description but of much lighter weight was made in England in 1828 from the collected combings during five years of the original herd in Weald Park, Brentwood, the yarn being spun at Darlington and woven at Paisley. This shawl, lent by the owner, Mr. C. J. H. Tower, after being shown privately to the Queen, was exhibited at the stand of the British Goat Society side by side with one of the royal shawls, specially lent also for the purpose, at the Jubilee Show of the Royal Agricultural Society of England held at Windsor in 1889. [H. S. H. P.]

Cassava, or **Mandioc.**—Names for a product of one or two species of plants, natives of South America from Guiana, Venezuela, and Colombia to Brazil and Peru. There are numerous cultivated races under each, viz. *Manihot utilissima*, the Bitter Cassava, and *M. palmata*, the Sweet Cassava; they belong to the order Euphorbiaceæ. They are extensively cultivated in most tropical countries, more especially in South America, the West Indies, Africa, India, &c.; are shrubby plants, from 6 to 10 ft. in height, and produce very large, fleshy, underground tubers. Those of the sweet cassava may be boiled and eaten as a vegetable, but those of the bitter species must be first specially prepared in the form of flour and biscuits before they can be eaten with safety. Nevertheless the latter is by far the most important, and in fact constitutes one of the chief articles of food with the people in all countries where plentifully grown. Propagation is accomplished by stem cuttings from 4 to 6 in. long. The ground, which must consist of a well-drained sandy loam, should be previously thoroughly ploughed or hoed and richly manured, then planted out in lines 4 by 6 ft. The cuttings are set at the crossings of the lines any time from September to May. The crop may be gathered in eight, twelve, or eighteen months, according to the stock grown and the climate of country. But the roots need not be dug up till quite convenient, though when once raised the preparation of the cassava meal and tapioca must be

undertaken at as early a date as possible. The returns are large, from 3000 to 30,000 lb. or more an acre. In fact, cassava may be spoken of as one of the most productive of crops, the yield of nutritive matter being often six times that of wheat.

The tubers must be thoroughly washed, then peeled or divested of the rind, and finally grated and pounded until reduced to pulp. This is then pressed within specially prepared baskets in order to drive out the juice, which may, in fact, be poisonous. The resulting partially dried meal is next sifted by means of sieves to remove fibrous and woody particles, and ultimately to assort it into various grades of fineness. Lastly, it is dried by heat, but never to such an extent as to colour the meal. The heat thus not only completes the process of drying, but drives off any remaining traces of the poisonous juice. *Cassava bread* is the flour moistened, kneaded into cakes, and fired. *Cassava starch* is the grated tubers or crudely formed meal cleaned, assorted by sieves, and repeatedly washed, then left in the last water until the sediment settles, when the water is decanted and the starch sun-dried. *Tapioca* is prepared from the poisonous juice set on one side when a considerable quantity of starch settles as a sediment. The liquid is poured off and the starch parched on heated metal plates. The starch grains swell, burst, and become agglutinated into the granular substance sold in the shops as tapioca. This is largely exported from Brazil. *Cassareep* is the poisonous juice boiled down into a thick fluid. In this condition it is a valuable antiseptic, and constitutes the chief ingredient of various sauces. *Piwarri* is an intoxicating drink prepared from Cassava cakes partially masticated by women, then expectorated into wooden vessels, and

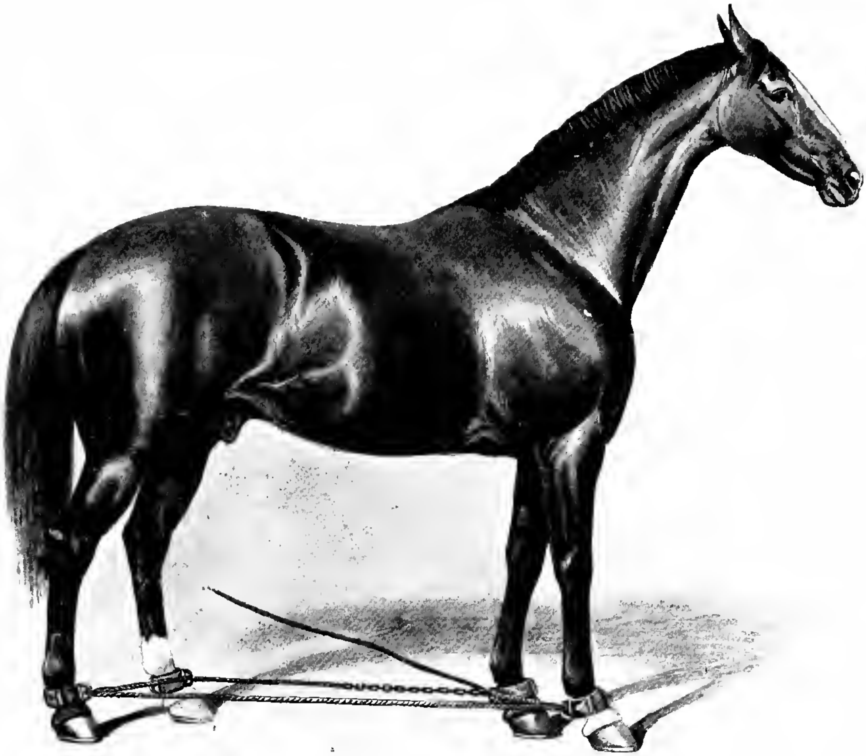
Cassava Plant and Roots

retained until fermentation takes place. It is now boiled, filtered, and in some cases distilled.

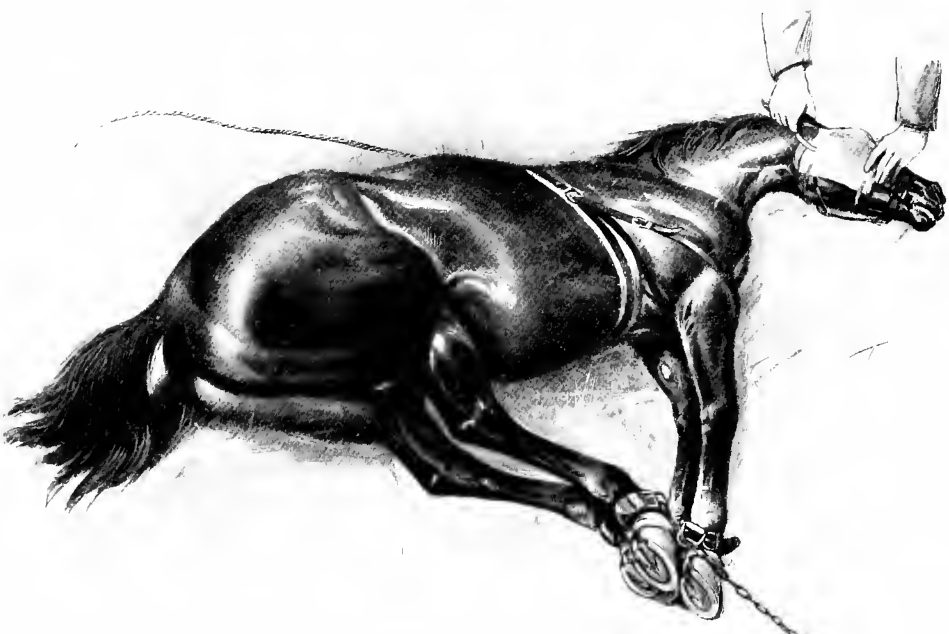
The poisonous property above alluded to proceeds from a glucoside present in the tubers, being often split up through the action of an enzyme, with the resulting formation of prussic acid. Heat destroys the enzyme (or ferment) and thus renders the formation of the poison impossible. [O. W.]

Castanea. See Chestnut, Spanish.

Casting a Horse.—There are circumstances, as for the major operations, when it is necessary to cast horses upon the ground and secure them, in order that they may do themselves no injury nor inflict damage upon the persons engaged. Other means of restraint will be found under the heading Methods of Control. Veterinary surgeons usually employ leather hobbles, one for each leg, and a cross hobble for better security of the limbs uppermost, when the horse is already upon its side. These are of very stout material, composed, in fact, of leaves of the very best leather compressed together and hand-sewn. Each hobble consists of two parts: a steel buckle and two steel eyes, one a little smaller than the other, in order that it may pass through it and serve for the passage of a rope, into the end of which is attached a strong metal chain as a continuation, and bearing all the strain when the animal struggles on the ground—a strain which would soon wear out any softer material. In the Plate, fig. A, the horse is seen standing with the hobbles adjusted, and the free end ready for the four or five men to pull in a backward direction, so that all four legs are brought together as shown in the next figure. Casting is facilitated by an over-rope attached to a surcingle, as in Plate, fig. B, or a strap under the arm of the opposite side to which the animal is intended to fall, and attached to the cord or over-rope, directed by a man who is not engaged with the hobble rope. When the legs have been pulled together, as in fig. B, a spring hook in the form of a 'D' is inserted in a link of the chain previously mentioned. This relieves the men from the necessity of pulling all the time to keep the feet together, and enables the operator to release a limb or vary the distance between the feet by shifting the spring hook to another link of the chain. If a pastern has to be operated upon, the hobble is unbuckled, and reliance is placed on the cross hobble above the knee and hock. To reduce the risk of spinal injury many operators have a check rein from the head to the surcingle, which is provided with a buckle on the back, and to save the eyes from injury while on the ground a blinder is employed, as



HORSE HOBBLED



HORSE CAST

in Plate, fig. B. The latter is put on before the animal is cast, as likely to save a blow in falling, and as a means of restraint while affixing the hobbles—a process much resented by unbroken colts and other horses unaccustomed to much interference with their limbs. The best hobbles of the type we are considering are all released by the removal of a screw which attaches the chain end of the casting-rope to the near fore hobble; or if the animal is cast upon the near side, this hobble is used on the off fore limb. The attendants are by this freed

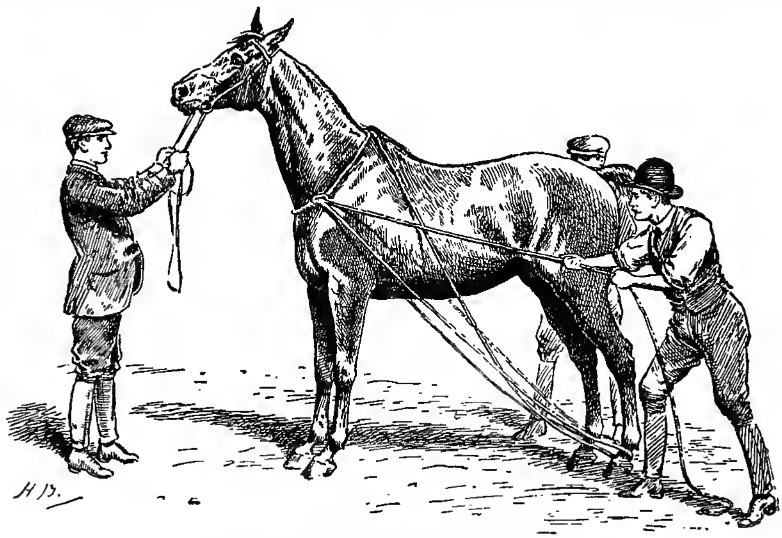


Fig. 1.—Arrangement of Rope for Casting a Horse

from the difficulty of separate unbuckling of the straps, and the horse is free to rise without risk of entanglement.

It may be remarked here that broken backs or other injuries are seldom incurred in the act of casting, but during the animal's struggles on the ground, and too much importance cannot be attached to keeping the head back and preventing the horse from getting his head towards the knees and obtaining a fulcrum. The most capable men should therefore be delegated to the charge of the head, if a scratch team has to suffice for the actual pulling down. The layman who may be called upon to cast an injured horse is at the disadvantage of amateur assistants, and in most instances an insufficient number. He will find a sack or two of corn placed across the neck, or other parts it is desired to restrain, of great help. In the absence of proper hobbles a full-length wagon rope free from knots will serve to cast the stoutest horse, and for particular purposes, as castration, ropes are preferable, as the limbs can by them be pulled up and the feet made to touch the belly (see Castration). To cast with a wagon rope, the ends are first brought together to equalize the sides or length, then a loop or

Fig. 2.—The Horse Cast

collar is formed where doubled, placed over the animal's head, with the knot upon the withers. A man on each side takes an end and passes it under the belly and between the hind legs (not between but outside the fore limbs), then crosses it to form a loop, drops the loop into the hollow above the foot and below the fetlock, and carries the free end through the collar or neck loop, and takes a few paces backwards. All is then ready, as in fig. 1. A smart pull all together, and not in the zigzag to be expected of novices, will bring down the

animal quite easily, many horses contributing to their own downfall as soon as they discover their entanglement. When down, the animal is further secured by half hitches around the pasterns, by halter ropes, and other contrivances. [H. L.]

Castle-Martin Cattle. — The South Wales Black, or as they were also called, the Castle-Martin, Cattle and the Anglesea or North Wales Black Cattle were at one time regarded as distinct breeds, and had separate herd books. The two societies were amalgamated in 1904, and the cattle of the north and south are no longer recognized as distinct breeds. See WELSH BLACK CATTLE.

Castor Oil. — This is obtained from the seeds of *Ricinus communis*, the Palma Christi, a member of the Spurgewort family (Euphorbiaceæ). Is commonly supposed to be a native of India, but, by some authors, of Africa. It has never been recorded as met with in an undoubted indigenous habitat in either country. It bears numerous vernacular names, mostly derived from the Sanskrit *eranda.* Is now cultivated in most tropical and warm temperate regions, and in some becomes even a troublesome weed. India is the most important source of the European supply. In the warmer areas of its production it is a perennial, and in the colder an annual, but where subjected to severe periodic rains it again becomes annual, being then grown during the drier months. It prefers well-drained loams, hence loose, sandy, or heavy clay soils are alike unsuited. There are numerous cultivated races, some directly utilized in the production of oil, others in the supply of the food-leaves for a silkworm (*Attacus ricini*), while a third series (often almost temperate) are ornamental foliage plants. Of the oil-yielding forms India may be viewed as possessing the most important assemblage, since that country now supplies a large proportion of the world's demands. The perennial plants are grown as hedges around, or as shade lines through the fields. These give a large seed and abundance of inferior oil. The annual plants are sometimes produced under pure cultivation, at other times as a mixed crop, have smaller seeds, and yield a much superior oil, the finer grades of which constitute the medicinal oil of commerce.

Castor Oil Plant

The oil is expressed either by a cold or a hot process, the former giving the finest quality. The yield ranges from 35 to 47 per cent. In India the seeds are often simply reduced to pulp and boiled till the oil rises to the surface. Here and there, however, European machinery may be seen employed in the separation of the oil, but the backwardness in that direction accounts for the great prosperity attained in Europe and America. Calcutta is mainly concerned in the production of the oil, using up approximately about one-half the quantity of seed that is exported from Bombay. The exports of oil from India have declined by half a million gallons since 1888–9, while the traffic in the seed has materially improved. The British imports of castor oil in 1888–9 were 122,843 cwt., valued at £160,421; and in 1906 they stood at 50,329 cwt., valued at £66,144. The chief countries of supply are Belgium, France, and Bengal, the former two working up very largely castor seed procured from Bombay. The exports of castor seed from India in 1906–7 were 1,505,059 cwt., valued at £761,128, and of that amount 649,874 cwt. were consigned to Great Britain and 844,746 cwt. to Continental ports.

Castor oil is largely burned, and gives a cooler and brighter light than any other vegetable oil. It is employed in mordanting alizarin-dyed fabrics and in dressing tanned leather. The cake is regarded as a good fuel, especially in the manufacture of gas, but it is never used as cattle food. It is, however, rich in nitrogen, hence is in demand as a special manure. [G. W.]

Castration.—The emasculation of animals is a practice of great antiquity, and is justified by the necessity of subjugation to man's uses, or of modification of the flesh of animals intended for consumption. It has been found necessary for horses working in association with mares, although entire animals are to be seen in the vehicles of great cities on the Continent of Europe and elsewhere. The flesh of emasculated cattle, sheep, and pigs is much superior to that of entire animals, which could not be grazed together indiscriminately. It is not

necessary to enter more fully into the reasons for the practice of castration, as they are generally conceded by persons engaged in animal industries.

There are a variety of methods adopted for the different species, as well as customs which pertain to certain countries and districts, the reasons for which are not always apparent, although commonly based on experience acquired in ages when secrecy rather than publication of knowledge was the rule, and when the practice of such operations was more or less of a hereditary craft. Custom prescribes that colts shall be castrated as yearlings in the early summer following on that of their birth, when the weather is fair and warm, and prior to the advent of the fly season. Exception should be taken to backward colts with undeveloped forehand, these being left until autumn or the following spring. Castration of sucking foals has been practised, but has not yielded satisfactory results in these islands, the subjects of such operation failing to develop in the neck and forehand. Postponement until the second or third year increases the risk, but there should be no inflexible rule, the owner being guided by special circumstances, such as we have already indicated.

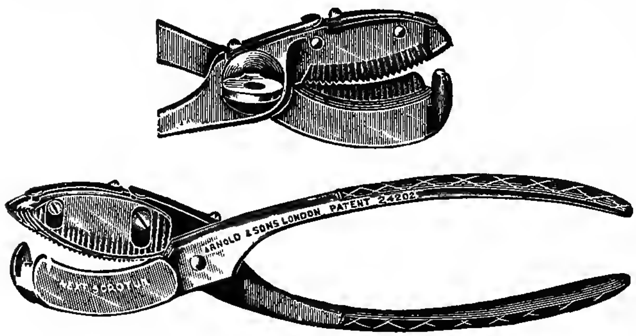


Fig. 1.—Crushing Instrument, or Ecraseur

In order to avoid all risk of injury in casting, many prefer the less humane practice of securing the colt by twitch and other means, and letting out each testicle separately by a bold stab of the knife from a scrotum made tense over the glands by a downward squeezing of the purse in one hand, leaving free the other hand to use the knife. The fatigue of the cremaster muscle soon allows the gland to swing clear, and then the operator either adopts the caustic clamp, which he secures upon the cord and leaves there, or uses a crushing implement such as the one here illustrated (fig. 1). Both methods produce pain, which can be avoided when an animal is first thrown in hobbles or by means of ropes, as shown in article Casting. The ecraseur or the improved instruments act on the same principle, and their application to ensure freedom from subsequent hæmorrhage must be slow and therefore painful. The more general plan of operation is to first cast the colt by means of ropes or hobbles (see Casting), when a more thorough examination for rupture or other deformity is easier than with the standing operation. Thus trammelled, we have the opportunity of inducing general anæsthesia by chloroform or other agents. Cleansing of the parts, and more particularly the removal of accumulations in the sheath, vulgarly known as cod wax, promote the prospects of recovery without excessive swelling, and the inconvenience experienced in protruding the penis during micturition. The testicles are liberated from their investments either by the knife or the hot iron, from a scrotum rendered tense by the means already described. The cord above and behind the epididymis is then severed while tightly held in a metal or wooden clamp (fig. 2). The most successful castrators, or a large majority of them, still give preference to the hot iron (fig. 3), which they employ at a dull red heat, dividing the back part of the cord which contains the artery somewhat slowly. This operation need not be hurried in order to spare the animal pain, as the grip of the clamps ensures the insensibility of the organ on the operative side. To seal the vessel a little powdered resin is often used, and the clamps are dressed with

Fig. 2.—Clamp for Castration by Firing

Fig. 3.—Castrating Iron

an antiseptic 'green castrator's ointment' composed of verdigris, Venice turpentine, and lard, which is further smeared upon the edges of the wound before the colt is released. Fire is, of course, the most perfectly aseptic agent we can employ, and long centuries of practice confirm

the desirability of this method of separation of living tissues.

The ligature commends itself to the eye as the most scientific method, at once clean and quick; but experience proves it to be the least successful in this country, although still much favoured by the French, and in some districts of Europe, where for special reasons the smallest wounds are desirable. Severance of the organs by torsion is another method of preventing hæmorrhage. The artery is drawn out by a rotary movement, after being secured by the special forceps. So far we have dealt with the horse in particular, but the main principles apply to other animals, with such differences as may now be set forth. In the case of the ass, and only to a lesser degree the mule, it may be said that there is a peculiar rigidity of the spermatic artery which prevents its contraction and plugging under the influence of the hot iron, in consequence of which severe hæmorrhage is apt to follow castration by the usual methods. For these animals, then, the ligature is to be preferred, despite the greater liability to tetanus which has been observed when animals of any species are emasculated by its aid. Besides the methods of caustic clamp, torsion, fire, and ligature, there is the ancient and cruel practice of trapping, which includes the scrotum with its contents in clamps or a ligature, whereby death and detachment subsequently takes place; and the Oriental custom of mulling, by which the stones are broken by softly hammering from the outside of the purse. Animals so treated were disqualified for sacrifice according to the Mosaic law, but the practice is still retained in some tropical regions, and had its origin in the fear of flies, and the introduction of septic matter by other means when open wounds were left after castration.

Calves are castrated at all ages, but the operation is less severe, and the check to progress is not so great, if done at an early age, from six to twelve weeks being the common custom. It often happens that a number of calves are saved that choice of a bull may be made, and those showing weak points are handed over to the castrator at twelve to eighteen months old, when the organs are much developed and greater care should be exercised. Calves and young bulls are thrown upon their side by means of a rope looped round the neck as a collar, and drawn round one hind leg, while the operator dexterously turns the animal's head and brings him down with his back towards himself, afterwards securing the uppermost hind limb and fixing it to the neck portion of the rope in a convenient manner for getting at the parts desired. The procedure is then much the same as described for colts. In laying open the scrotum of horses and bulls, of whatever age, a long bold incision should be made; not squeezing the testicle through the smallest aperture, but leaving abundance of room for drainage. With calves this precaution is specially necessary, as it is found that those animals which 'go wrong' afterwards do so almost invariably by the ready sealing up of the wounds, and retention of clots of blood which decompose. The testicle of the calf is usually drawn out, the cord strained to its fullest length, rapidly twisted, and then divided by scraping with the knife; not directly cutting through it, as the latter is liable to be succeeded by hæmorrhage. In the western counties of England, searing with a flat-shaped iron is the general custom. With or without the verdigris ointment or other antiseptic dressing, calves commonly do well.

Regarding lambs, custom varies greatly in different districts, some flockmasters preferring to castrate at two or three weeks, and others deferring the operation until as many months have elapsed, or even later. Losses from death may not be greater in the older lambs, but the value is, of course, much more. Small lambs are held with all their feet in the hands of a man, who presses the back against his own chest, while the operator stands in front, elongates the purse with finger and thumb of one hand, while cutting off an inch, more or less, and exposing the ends of both testes at once. These he may seize singly in his teeth, or in an instrument

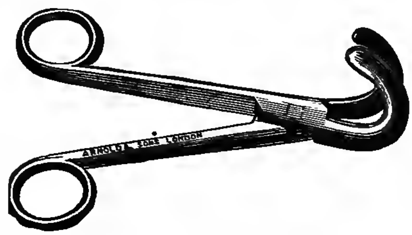
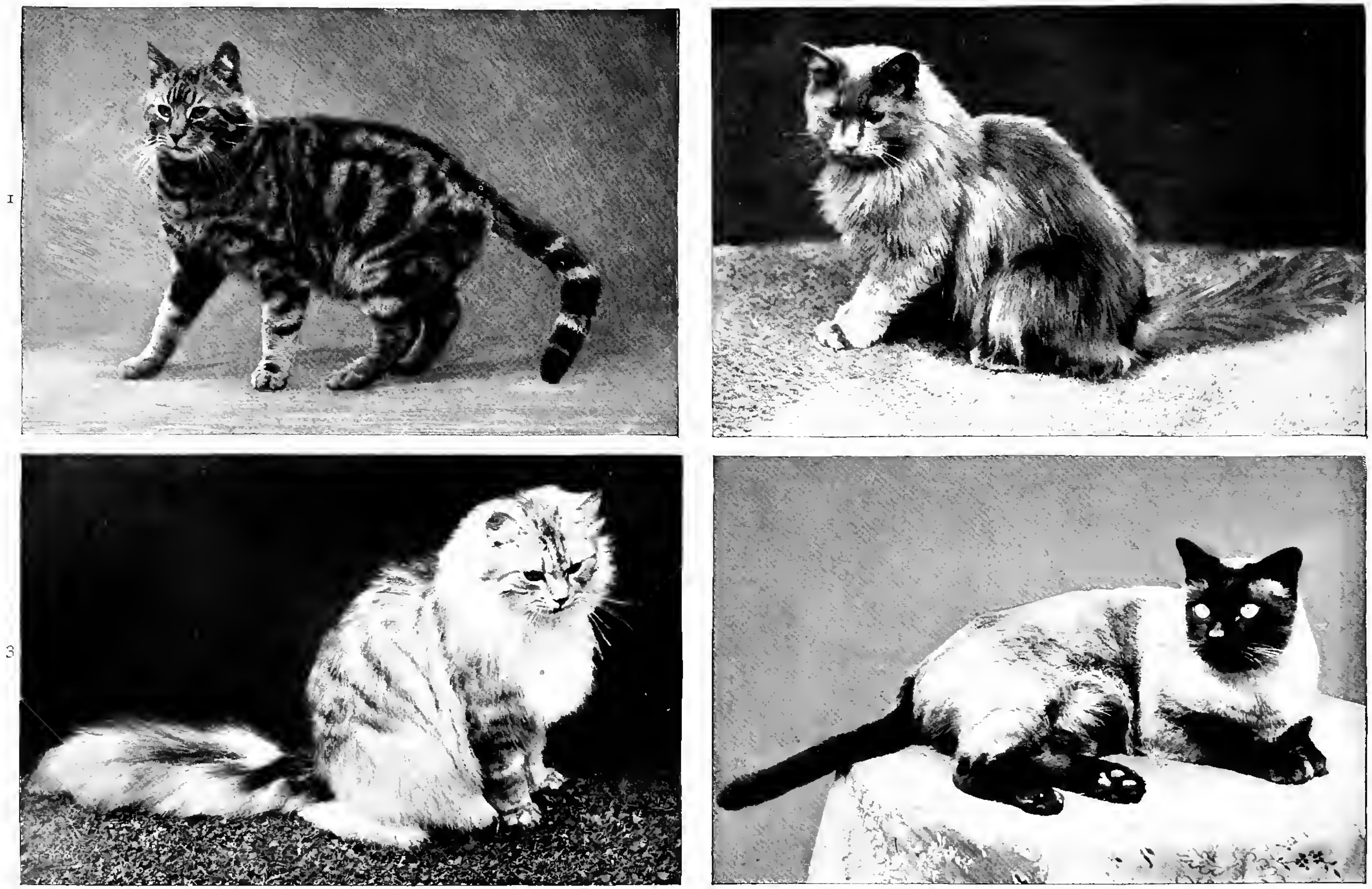


Fig. 4.—Instrument for the Castration of Lambs

(fig. 4) made for the purpose, and draw out until the cord breaks away. This rough form of torsion answers well, and has been so practised by South Down shepherds from time immemorial. Searing still obtains in some districts, but for very young lambs is a slow, laborious, and unnecessary performance. In the case of older lambs, or of rams doomed to the knife for various reasons, the hot iron should be used, and the verdigris ointment freely employed, there being marked tendency to septic poisoning in the castration of adults.

Pigs are the easiest of animals to castrate, and many breeders perform the operation themselves, merely cutting open each division of the scrotum, pressing out the testicle, drawing it a little way, first dividing the least vascular part, and next the soft portion in which the artery and vein are situated. A little hæmorrhage is not objectionable, and it is remarkable that so few casualties occur among these animals, having regard to their commonly filthy surroundings, and their retirement upon foul litter immediately after operation, unless driven from home. [H. L.]

Cat, The (*Felis domesticus*).—The cat, like the dog, fox, weasel, &c., belongs to the Carnivora or flesh-eating animals, and in company with certain other members, such as the lion, tiger, &c., forms a family group known as the Felidæ or Cat tribe, all of which are very silent when in search of their prey, springing suddenly upon the latter, seizing it with their



From photographs by Thomas Fall.

SOME TYPICAL CATS

1 Common Domestic Cat; 2, Blue-smoke Persian; 3, Persian; 4, Siamese

sharp-pointed retractile claws, which they use with great ferocity and effect. A very characteristic feature of the Felidæ is the 'spotted' or 'striped' markings upon the fur, and everyone must know that cats with such markings upon them are more abundant than whole-coloured specimens, even though the last named are so common in a state of domestication. The use of the markings is to render the animal less conspicuous whilst hunting its prey. As just stated, the Felidæ have retractile claws, the last inter-phalangeal joint having an elastic ligament, which is fixed to the outer side of the lower end of the second phalanx, and by the other (lower) end to the last phalanx, immediately above the root of the claw. Contraction of the ligament draws the claw inwards. The act of projecting the claw is obviously a voluntary one, and employed not only as a means of offence and defence, but also for climbing purposes. The head is short and round; the ears small, with the auditory opening so placed as to give the best advantages for hearing sounds; the jaws short and strong; the neck short; the limbs short, and the body carried close to the ground during the stealthy but swift movements.

Regarding the origin of the cat, nothing dogmatic can be asserted, but it is generally accepted that the Domestic Cat has been derived from the Mountain or Forest Cat (*Felix Catus*), inhabiting either Africa, Asia, or Europe. Fossil remains of the cat have been discovered in the Upper Eocene in Europe, and in Asia similar remains have been found in the Upper Miocene, and in the United States in the Lower Miocene, therefore the fact suggests the possibility as to the European Continent being the home of the cat. Throughout the African Continent there is a small cat, similar in build to our domestic cat. It is often referred to as the Egyptian Cat, and the Egyptians regarded the cat as a sacred animal, the mummified remains of many of these animals being still in existence. The Egyptian cat will breed with our own, and its markings are similar. In northern India there is a spotted variety of cat, and the domestic cats now found throughout Hindustan have been derived from this source.

Quite apart from the foregoing, there has existed a European wild cat from the remotest times down to the present day, according to some; and it is only recently that the author saw a huge animal, reputed to be a genuine specimen of the wild cat (shot in Scotland), stuffed, and placed under glass at an exhibition. It is a very difficult matter to prove that such animals are anything more than fine big domestic cats, leading a rapacious existence, as all cats have a strong inclination towards reverting to their natural condition. The genuine Wild Cat (*Felis Catus*), specimens of which can be seen in most museums, is usually of a bigger type than the domestic pussy, although one sees some huge male specimens of the last named. The head is large; the tail thick, striped with black rings, and black at the tip. Beneath the throat, chin, and belly, the fur is white, also the toes. The markings are very similar to those of the domestic cat, but the whiskers are much longer and coarser. Males are larger than the females, and the general build of the true wild cat is much stouter than that of the domestic pussy. Domestication, excepting in the case of animals selected for exhibition purposes, has reduced the cat somewhat in size. There is evidence to show that the true wild cat still exists, especially in Caithness-shire, North Wales, &c.

The long-haired cats have been produced by crossing with the Persian, which now exist in both whole and mixed colours. The Persian or long-haired cats are highly esteemed, and pure-bred specimens of the A1 class very often bring high prices, as much as thirty and forty guineas being frequently paid for such. As a product of a first cross between a Persian and a short-hair, the result is generally a cat with fur of medium length; but it is better to avoid such cross-breeding, using short hair with short hair, and long hair with long hair. By interbreeding, selection, and the introduction of Persian blood, the stripes have either disappeared or else become modified.

In the skull of the cat the cranial cavity is large. The ribs number 18 pairs; the head of the last rib is not divided, because this rib articulates with the body of only one vertebra. The breast bone is composed of 8 pieces. The fore limb has a clavicle or collar bone, though such is very small, and this is succeeded by the scapula or shoulder blade, which articulates below with the humerus or arm-bone, and this in its turn with the forearm, consisting of the radius and ulna. The manus, *i.e.* the wrist (knee) and foot, is composed of 7 bones, together with 5 metacarpal bones and 5 digits, the innermost one being the smallest, and this corresponds to the thumb in the human subject. The hind limbs consist of the pelvis or basin bone, which serves to unite the hind limbs to the vertebral column. The femur or first thigh bone follows, and then the tibia plus the fibula or second thigh. The kneecap is formed by a small bone, the patella, which along with ligaments and the ends of the two thigh bones, forms the stifle joint. The hock joint or tarsus has 7 small bones in it, whilst the foot has 4 bones, and the digits to correspond. The spinal column consists of 7 cervical or neck bones, 13 dorsal or back bones; 7 bones in the loin and 3 in the sacrum, with a variable number in the tail.

Amongst the different varieties of cats mention must be made of the Manx, which even half a century since was becoming scarce, chiefly through breeding with cats from the mainland. The true Manx cat was destitute of its caudal appendage, though the mere absence of a tail does not necessarily indicate that the animal is a Manx cat, as such a large number have had their tails removed in order to deceive unwary purchasers. The most characteristic feature of these island cats is the length of the hind limbs, giving them the appearance of a hare in the upright sitting posture. This should prevent anyone from being deceived by having a hybrid kitten palmed off for a true Manx specimen, of which very few are said to exist. Manx cats were formerly known in England as 'Cornish cats', and it is probable that such exist in Cornwall at the present time. The absence of

the tail does not render them any more useful than the 'tailed' cat, though it gives them a peculiar appearance behind, not unlike the bob-tailed sheep dog in this respect.

Cats are extremely useful about the farm, the short-haired varieties being those usually found around the steading. Cats breed so freely that it does not take long to have a small colony, but this can be regulated by castrating the males when they are from four to six months old. It is better to do this simple operation a little late than early, so that the animal has time to develop some of the male characteristics, which is averted by 'castrating' before three months. The scrotum is simply incised with a sharp penknife, and the testicle then drawn out, just as done with pigs. No after-treatment whatever is necessary. Cat must be securely held meanwhile. The female cats can be 'spayed' to prevent breeding, only this is a much more troublesome operation, and one quite incapable of being performed by anyone but an expert.

With reference to the best colour for cats, something must be said. For town, either black, blue, or one with tabby markings is preferable, but in the country white or other light colours are easily kept clean, and look very handsome about the steading. Many farmhouse cats are very keen on the destruction of rats, consequently they should be allowed free access to the cattle houses, the stables, the fodder house, loft, and corn room; and if about a dozen of such good vermin destroyers are kept about the homestead, they will certainly repay the owner a hundredfold.

It is advisable to give them a good supply of milk each day, say every morning at the same time, so that the whole family will meet with the regularity of the clock and partake of a hearty draught of this wholesome food. It is better to encourage them to come up in this manner, and then they will always look for it and thrive upon it. They can be fed out of a couple of large shallow tins. It also keeps cats from wandering far from home and falling victims to the keeper's gun or snare, as cats constitute the gamekeeper's principal enemy. Once a cat gives itself up to poaching, it can never be weaned of the habit, owing to the fascination and inclination towards reverting to its ancestral state. It is not advisable to give cats much food, otherwise they will not trouble to keep killing rats, mice, birds, &c., though each ought to have a little food given when they 'come up for morning milk'.

Cats are subject to many diseases, some of which they occasionally acquire from the live stock of the farm, and in other instances from devouring the offal of a diseased carcass, whilst certain skin diseases are acquired from rats and mice, from calves, or from the horse. They are sometimes the medium of spreading disease amongst live stock, and ringworm is often transmitted through a cat to other animals, or to members of the household. The principal skin diseases are mange, eczema, and ringworm, and the commonest catarrhal disease is distemper, from which many cats die. It is popularly known as 'snuffles'. Mange is denoted by the hair falling out in patches, which gradually extend, and there may be numerous sores on the body. One cat will readily infect another, by *direct* or *indirect* contact, so that if any of the cats on the farm show signs of this complaint, it is the most economical plan to destroy such at once. Another fairly common disease is tuberculosis or consumption, which is contracted as a rule through eating tuberculous flesh, such as the liver of a diseased fowl, turkey, &c. The animal begins to cough, loses condition, and gradually wastes away. The sooner the animal so affected is poisoned the better, as it is liable to infect children and other animals if allowed to associate with them, or contaminate milk, as many cats are notorious thieves. [F. T. B.]

Catabomba pyrastri (Large Hover Fly), one of the largest hover flies or Syrphidæ, which occurs in summer and autumn. Its body is banded with black and white; the single pair of wings are transparent; length ½ in., wing expanse nearly 1 in. Found hovering over groups of plant lice, especially those on roses. It places its eggs amongst the aphides, and the larvæ coming from them feed upon the aphides, which they destroy in large numbers. The leech-like maggots pupate in a bladder-like case attached to the leaves. [F. V. T.]

Catalepsy.—Very little is known as to the condition of the nerve centres which gives rise to catalepsy and other 'fits' in animals, but they are frequently associated with internal parasitism, irregular dentition, and indigestion. Horses are almost immune, young cattle, pigs, and dogs are not infrequent subjects, and sheep in certain well-defined areas suffer from fits more or less resembling catalepsy (see LOUPING ILL). Eclampsia and chorea have certain features of resemblance, but differ from catalepsy as known to medical practitioners. Animals suffering from fits of the cataleptic type should receive such treatment as will evict parasites, open the bowels, and restore digestion, not forgetting the extraction of supernumerary teeth, or such as have been retained after the proper time of shedding them has passed. [H. L.]

Cataract.—Cataract may be defined as any opacity of the lens or its capsule, whether involving a part or the whole. Its presence in a horse constitutes a serious form of unsoundness, as any defect of vision may lead to accident to the rider or driver. It is, however, a well-known fact that cataract less often leads to the dangerous habit of shying than does astigmatism from defective formation of the cornea or front of the eye, spots upon which are often mistakenly spoken of as cataract. The causes are often obscure, but any persistent inflammatory condition may lead to such opacities, which usually remain, if they do not gradually increase or become more dense, and encroach still further upon the field of vision. As operation would necessitate the subsequent wearing of spectacles, it is out of the question so far as the lower animals are concerned. Animals kept for milk or destined for the butcher are not seriously incommoded, as the other special senses enable them to find their way about, and distin-

guish between food that is suitable or otherwise. See art. BLINDNESS. [H. L.]

Catarrh, or **Cold.**—The malady popularly known as 'a cold', and recognized as catarrh by veterinary writers, is an inflamed state of the upper portions of the air passages, with more or less discharge from the mucous membranes, in which the eyes often sympathize and add to the flow by the escape of tears down the lachrymal ducts, whose openings are upon the floor of the nasal chamber. An inflamed condition of other mucous membranes, as those of the vagina, the urethral canal, the bowels, &c., are elsewhere referred to as catarrh or a catarrhal condition, although the common application of the word 'cold' has the limited meaning above defined. The causes of catarrh in animals are much the same as those inducing the malady in human beings; but certain circumstances over which animals in servitude have no control render them specially liable, as the clipping of horses in winter, and sudden cooling down when standing outdoors while waiting in saddle or harness, and without the clothing they are made to wear in the warm stable (see CLIPPING). Catarrh of the respiratory membranes is much to be feared in horses, because of the frequency with which it leaves behind some serious defect, as whistling, roaring, thick wind, &c., which see. Impure air is observed to produce catarrh, as in horses brought in from grass to the bad air of the crowded stable; while those removed from the warmth of the stable to the cold but purer atmosphere of the field seldom suffer, or quickly recover if chilled at first by reason of having been clipped. Pure cold air, with clothing to retain the bodily warmth, may be considered the best treatment for simple catarrh uncomplicated by other troubles. All the domesticated animals are subject to catarrh, and in proportion as their management is artificial, or more remote from natural conditions. See BRONCHITIS, LARYNGITIS, and other respiratory diseases. [H. L.]

Catch Cropping.—A 'catch' or 'stolen' crop is one that is grown between the regular annual crops of the rotation, and which is not considered the main crop of the year. The chief crop of the year occupies the ground during the summer months, while the catch or 'interpolated' crop has its active period of growth in the autumn, and perhaps also in the spring. In market gardening the practice of growing interpolated crops is quite common, but in ordinary agriculture it is restricted in cold and temperate climates, and is only extensively practised in warm countries such as Italy, where numerous secondary crops are successfully grown after the ordinary corn harvest. In Great Britain the practice is most widely followed in the southern parts of England, where the winters are short, the autumns mild, and the spring early. In the north of England and in Scotland, where the climate is more severe, catch cropping is much more restricted, while in Ireland, though the conditions of climate are more suitable, catch cropping is not widely practised.

The crops most suitable for the purpose are those that grow rapidly, that give a large yield of nutritive green forage. The most suitable and the most extensively grown are Italian ryegrass and rye, mustard and rape, vetches, trefoil, and trifolium; but winter barley, winter oats, turnips, cabbages, thousand-headed kale, and others are all found useful for this purpose under certain conditions.

In Scotland and Ireland catch crops are chiefly grown after early potatoes, which may be raised in June or July. The land is at once sown out with rape, Italian ryegrass, or other crop, which is ready for consumption by sheep in the autumn, and before Christmas the land is usually clear and ready to be prepared for the next crop. In the south of England a more general practice is to sow a catch crop on the stubble after wheat harvest, and usually from August to October. The land is rapidly and, as a rule, lightly cultivated, and the seed sown with as little delay as possible. By a proper arrangement a succession of suitable green food can be secured from autumn to spring. Mustard, which is the quickest growing of all the crops, may be ready to feed stock in September, and rape may be ready in October, while stubble will then supply feed right through the winter. In February and March, winter rye will be ready for use, and barley and then vetches will follow, and after these crops have been consumed, the land can be ploughed in good time for the sowing of the regular rotation crop of turnips.

In Scotland the practice has recently been introduced of sowing along with the lea oats in spring about 6 lb. red clover seed per acre. After the oats have been harvested the clover continues to grow, and in some seasons gives a fair amount of produce. But apart from its value for grazing purposes, the practice has been proved to be a very profitable means of enriching the soil with nitrogenous matter derived from the decaying clover roots. The quantity of such roots produced naturally varies, but an idea of its amount may be formed from the results of an experiment carried out on the Central Experiment Station, Ottawa, Canada, where it was found in 1897 that the average weight of clover roots in the upper 9 in. of the soil amounted to about 3 tons per acre. The effects of this nitrogenous residue in enriching a soil have been repeatedly shown in experiments carried out by the writer at the Experiment Station of the West of Scotland Agricultural College. In 1903, 1904, and 1906, red clover seeds were sown with the oat crop on certain plots, and on similar adjacent plots the oats were sown without red clover. The aftermath of the red clover plots was ploughed in during the succeeding winter, and the plots were sown down to barley in the following spring. The yields of the plots calculated into returns per acre were as follows:—

PRODUCE OF BARLEY CROP

	Without clover grass.		With red clover grass.	
	Grain. lb.	Straw. cwt.	Grain. lb.	Straw. cwt.
1904 ...	2327	26	2647	33¼
1905 ...	2790	25¼	2875	25
1906 ...	2480	27¾	3440	39½
3)	7597	79	8962	97¾
Average	2532	26⅓	2987	32½

Similar results have been obtained on some of the Canadian experiment stations, and this method of enriching the soil by the growth of a catch crop of red clover appears therefore to be very widely practicable.

The advantages of the practice of catch cropping are numerous and important. By means of the system the ground is kept covered during a greater part of the season by growing crops, and weeds are thus kept in check and partially destroyed. The amount of moisture transferred through the plants is greatly increased, while the proportion of rainfall that passes through to the drains is correspondingly reduced. The loss of soluble nitrates caused by drainage is therefore materially diminished. Moreover, if the catch crops grown be of the Leguminosæ, as vetches and trifolium, they leave the soil greatly enriched in nitrogen, derived by them from the atmosphere by means of the bacteria contained in their plant roots. By catch cropping, therefore, the nitrogen of the soil is in the one way preserved from loss, while in the other it is substantially increased. Moreover, the growth of crops of which the greater part is usually consumed on the land makes important additions to the store of organic matter in the soil, and on most soils, apart altogether from its contents in nitrogen, an addition to its stock of organic matter is attended with many other advantages.

But it is in some respects in its effects on the stock-carrying capacity of the farm that the practice of catch cropping is most advantageous. By this means supplies of succulent green food are provided in autumn after summer grasses have failed; while during the difficult and trying period of spring, the stockmaster is enabled by means of early catch crops to maintain a herd of stock on the farm, which otherwise would be impossible.

But it is not to be forgotten that there is a limit to the practice of successful catch cropping. The cost of their cultivation is not great, but total or partial failures of catch crops are also not uncommon, and the practice can only be considered a good one where the returns can be estimated to be substantially greater than the expenditure. [R. P. W.]

Catchfly.—This name is often applied to campions, because of the viscid hairs on their flower-stalks. See CAMPION. [A. N. M'A.]

Catch-work, a system of irrigation practised on sloping meadow lands. Water derived from a stream or river is caused to flow into a feeding channel which runs along the top of the field. The feeding channel is dammed up at some point in its course, causing the water to overflow the surface of the field. The water soon ceases to spread itself uniformly over the surface, and tends to collect into little streams. To obviate this, small gutters a few inches deep, made by the gripping plough, are drawn across the surface of the slope as nearly as possible along contour lines. The water from the feeding channel collects in these, and these in turn overflow, till finally any unabsorbed water is drawn off at the bottom of the field by a discharge channel. See IRRIGATION. [R. H. L.]

Catechu, or **Cutch.**—This is an extract prepared from the wood of *Acacia Catechu*, a tree which belongs to the Leguminosæ, and is met with all over the tropical areas of India and Burma. There are three varieties of the tree, which afford corresponding trade qualities of the extract. These are: (*a*) *Catechu* (proper), from which is made the Pale Catechu of Kumaon—*kath* as it is known in Indian trade, an article eaten largely in *pan* or used medicinally; (*b*) *Catechuoides*, the Dark Catechu or Pegu Cutch, the *khair* of Indian commerce and the chief product, is used mainly as a tanning and dyeing material, especially in the colouring of fishing lines and nets; and (*c*) *Sundra*, the Red Cutch of the Deccan and South India.

In the preparation of the extract the trees are felled, specially prepared logs are barked, have their sapwood removed and rejected, while the heartwood is cut up into little chips. These are packed into earthen pots and boiled with water until 4 gal. have been reduced by one half. The liquid thus obtained from thirty pots is thrown into a large iron cauldron and boiling continued until it assumes the consistence of syrup. The cauldron is then lifted off the fire and its contents stirred with a wooden implement for four hours. The thickened extract is next thrown into wooden moulds lined with leaves, and left to cool. The following morning it is removed, and then appears as large dark-red bricks, marked by the veins of leaves, each weighing from 36 to 44 lb. The manufacture usually takes place from December to March, and the proceeds of one cauldron during the whole working season may be from 2000 to 6000 lb. It has been estimated that a ton of wood yields from 250 to 300 lb. of extract. Pale Catechu is considerably different from the Pegu Cutch. When the extract has been concentrated to a certain extent it is set aside, but instead of being lashed for hours, twigs are at once placed within the hot liquid, and, on cooling, upon these a crystalline deposit is gradually thrown down. This is removed and pressed into the large irregular cubes that constitute *kath*. *Khersal* is a crystalline substance found naturally within the wood on its being cut up. It is collected carefully, since it fetches a high price, and is much valued by the Hindus. The Burma production of 'Pegu Cutch' averages about 130,000 to 150,000 cwt., the whole of India adding to that quantity about 30,000 cwt. The trade seems, if anything, to be declining, though it has always manifested extreme fluctuations. Systematic cultivation to meet the heavy drain on the forests can hardly be said to be seriously pursued so far, and the supplies are getting greatly restricted. Cutch is largely utilized in tanning fishing lines and nets, and for certain grades of skins and hides. [G. W.]

Caterpillar.—The caterpillar is the larval stage of the group of insects known as the Lepidoptera, which includes the butterflies and the moths. The body is worm-like in appearance, and composed of thirteen segments; the head is horny, and armed with hard biting mouth parts; the lower lip is provided with spinning glands, used in weaving the silken cocoon.

The first three body segments, which correspond to the pro-, meso-, and meta-thorax of the mature insect, have each a pair of jointed legs on their ventral surface, while the ten abdominal segments behind bear a varying number of fleshy protuberances called *prolegs* or sucker feet. These prolegs are retractile, and are usually ten in number, *e.g.* in the larvæ of butterflies; but in the looper caterpillars only two pairs of prolegs are to be found in the posterior segments. In larvæ of this type the body is characteristically bent when in motion, and when at rest the hinder part is coiled up spirally. Many caterpillars are beautifully coloured; these being provided with a hairy protective covering; smooth-skinned caterpillars are either greenish or brown.

All caterpillars are vegetable feeders, perhaps the most destructive being those of the Diamond-back Moth, the Winter Moth, the Cabbage Moth, and the Antler Moth. The only useful species is the 'silkworm'. [R. H. L.]

Cat's Tail, a name given to several plants, especially the Reed-mace, *Typha latifolia.*

Cat's Tail Grass, a popular name for Timothy Grass. See TIMOTHY.

Cattle.—At the beginning of the Tertiary epoch the hoofed mammals (ungulates) were represented by primitive small-brained forms about the size of a fox, with five toes on each foot, and a typical set of teeth as follows:—

$$i.\ \frac{3}{3},\ c.\ \frac{1}{1},\ p.m.\ \frac{4}{4},\ m.\ \frac{3}{3}.$$

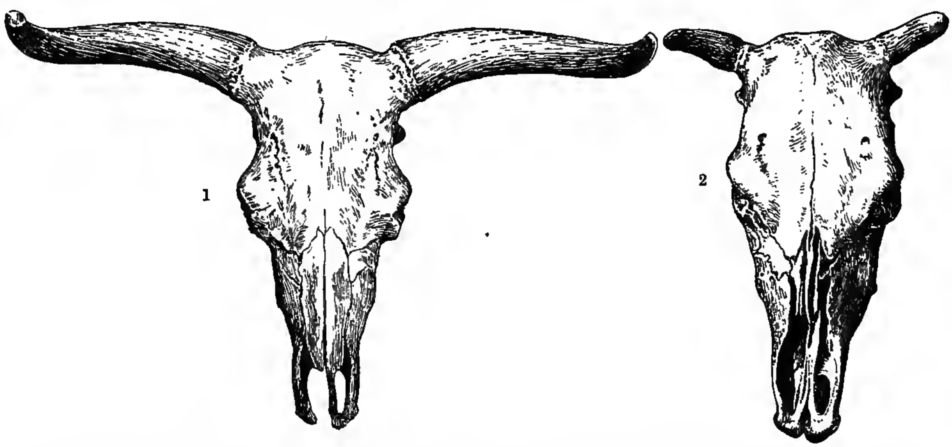
But in course of time the ungulates began to specialize in several directions, with the result that two distinct types were eventually produced, one with the third (middle) toe of each foot enlarged; one with the third and fourth toes larger than the others, and forming a symmetrical pair. From the first came the tapirs, horses, and other *odd-toed* ungulates; from the second the sheep, camels, oxen, and other *even-toed* ungulates. For untold ages the even-toed ungulates retained their primitive characters, but by and by the teeth, limbs, and other structures were considerably modified, and species were subsequently produced which remotely resembled the deer, antelopes, camels, and oxen of recent times. As the evolution of the ox family (Bovidæ) proceeded, the incisor and canine teeth completely disappeared from the upper jaw, and the first of the four premolars was lost in both upper and lower jaws. Further, as the third and fourth toes increased in importance the first disappeared, the second and fifth were reduced until only useless vestiges were left, and the third and fourth metapodial (metacarpal and metatarsal) bones, after elongating, coalesced to form the single bone which carries the third and fourth digits. As the canines disappeared, horns were in many cases developed in connection with the frontals.

The above changes were effected mainly during the Miocene period, and the progress was so rapid towards the close of the Miocene, that early in Pliocene times true oxen made their appearance in India, and probably also in Europe. From the Indian species (*Bos indicus*) have descended the zebu and other humped varieties of cattle; from a European species (*Bos primigenius*) have sprung all the long-horned, shorthorned, and hornless breeds of humpless cattle. The wild ancestors of the humped as well as the humpless cattle are now extinct. When *B. indicus* and *B. primigenius* ceased to exist in a wild state it is impossible to say. We know, however, that *B. primigenius* (the urus of the Romans and the aurochs of the Germans) was widely distributed over Europe during the Ice Age. In Britain it occurred along with the Irish elk, mammoth, woolly rhinoceros, cave lion, and other extinct species hunted by our Palæolithic ancestors. *B. primigenius* was especially remarkable for its huge size and large curved horns. Some of the aurochs which inhabited the Thames valley in prehistoric times must have measured 7 ft. at the withers, and carried horns over 3 ft. in length with a girth of over 20 in. at the base. During the Stone Age (as stone implements embedded in skulls eloquently testify) the urus was successfully hunted in Britain; during the Bronze Age it was as successfully tamed and domesticated in Switzerland. Evidence of the domestication of the great ox during the Bronze Age was obtained during the excavation of the Swiss lake-dwellings. The bones from the pile-dwellings not only indicate that the Neoliths tamed the urus, but that it had been long enough living under domestication to have varied in several directions. It is conceivable that the urus was domesticated in Britain as well as on the Continent, and that in the Chillingham, Chartley, Cadzow, and other herds of white cattle we have the dwarfed and otherwise modified descendants of *Bos primigenius.* There is, however, no evidence that the urus was domesticated in the British Islands, or that it was living in a wild state in Britain at the Roman invasion. In certain deposits in the Thames valley, in the English Fens, in Lancashire, Fifeshire, Perthshire, and elsewhere, remains of the urus have been found, but the only ox represented in the deposits of a somewhat later period is the small marsh cow (Celtic Shorthorn), originally brought to Central Europe by the Neoliths. Cæsar refers to the huge specimens of the urus he came across in the Hercynian Forest, but Cæsar evidently neither saw nor heard of the existence of the urus in Britain. In all probability *B. primigenius* became extinct in Britain during the last cold phase of the Glacial epoch, when the forests over a considerable part of Scotland were invaded, and to a large extent destroyed, by the growth of peat bogs such as still occur in the Moor of Rannoch.

The view that *B. primigenius* became extinct in Britain is supported by the bones discovered during the excavation of Roman camps and settlements. The urus is more likely to have survived in Scotland than in England. Nevertheless the excavations in Scotland, like those in England, have hitherto yielded no bones of *B. primigenius.* The Roman forts of Bar Hill and Newstead, *e.g.*, have yielded a number of skulls of the Celtic Shorthorn—skulls which

belonged to a polled or hornless race, and skulls with upturned horn cores double the length and nearly twice the girth of the horn cores of the Celtic ox, and yet very different from the horn cores of *B. primigenius* from earlier deposits. But even were it subsequently made out that the Chillingham and other Park cattle were the direct descendants of a British wild variety of the urus, this fact would have little direct bearing on the origin of British breeds of cattle, for it is admitted that both shorthorn and hornless as well as longhorned breeds have descended from *B. primigenius.* Though the urus in all probability became extinct in Britain, it continued to flourish on the Continent up to, it is said, the eighth century. In all probability, during the ten or more thousand years which elapsed from the domestication of the urus during the Bronze Age and its extinction in the eighth century, wild specimens were frequently captured and made use of to rejuvenate the tame herds. But even if this happened, the changes in size, horns, limbs, &c., due to domestication and isolation, to intentional and unintentional selection, and to the influence of different environments, would continue, and result in the formation of more or less distinct races and breeds—some with short curved horns, others with long upturned horns, and others devoid of horns. That this actually happened, the bones found at Bar Hill, Newstead, and many other Roman stations in Britain and on the Continent afford abundant evidence.

The oldest known offshoot from the main urus stem is the small Celtic ox, plentifully represented amongst the bones from the Swiss lake-



1, *Bos primigenius* (Urus), found at Blair Atholl, Scotland. 2, *Bos primigenius longifrons* (Celtic Shorthorn, Scotland).

dwellings and from settlements in various parts of Europe during the La Tène and still later periods. Owen thought the Celtic shorthorn had descended from a small wild species to which he gave the name *Bos longifrons.* It is, however, now generally admitted that the Celtic ox must be regarded as a variety of *B. primigenius* which had been dwarfed by unfavourable surroundings either before or after its domestication during the Stone Age. When and where the Celtic ox was first domesticated it is impossible to say. In all probability it first reached Central Europe with the Neoliths, and then gradually found its way to Germany, the Low Countries, France, and the British Islands. The Celtic shorthorn, which seems to have varied little (in all probability it was an inbred prepotent race), is still by many regarded as having taken an important part in forming the British breeds found in the south and west of England, the west and north of Scotland, and the south-west of Ireland, more especially the Jersey breed, certain Cornish, Welsh, Cumberland, Galloway, and Highland breeds, and the Irish Moyle and Kerry breeds. To what extent the marsh cow of the Neoliths contributed characters to these and other breeds it is difficult to estimate. The Celtic ox, though it long persisted in Wales and Westmorland, no longer survives; but by blending the Jersey and the old mouse-dun Shetland breeds the writer has obtained an ox which probably both in horns, make, and colour closely resembles the variety of the marsh cow which was widely distributed over the British Islands before the coming of the Romans. The Celtic shorthorn was especially remarkable for its small size, the shortness of the horns (hence the name *B. brachyceras*), the length of the forehead (hence Owen's name *B. longifrons*), and the fineness of the limbs. In a specimen from Newstead the horn cores are only 4 in. in length, while the forehead is long owing to the frontal bones projecting upwards to form a prominent ridge, from the extremities of which the small horns project outwards and forwards. The trunk was short, and sufficiently light to be easily supported by limbs as fine as in a stag of a like size. It is generally assumed that the marsh ox was of a dun or brown colour. This view is supported by the Shetland–Jersey crosses, which are either a dark mouse or reddish-brown colour, with a light-coloured broad dorsal band. The difference between the skulls of the urus and the Celtic ox are brought out by the accompanying figures.

Though the Celtic shorthorn seems to have been the only domesticated breed of cattle in Britain up to the Roman invasion, there were several breeds in pre-Roman times on the Continent. Of these one of the best known is the Frisian breed — a breed which, according to Rütimeyer and others, retained all the more striking points of the urus. It was tall, stoutly built, with strong limbs and long horns which, as in the urus, first arched outwards then forwards and downwards, and ended in points which approached each other with an upward curve. By the blending of cattle of the urus and Celtic shorthorn types, numerous more or less distinct races were in course of time produced on the Continent. Some of these blends probably reached Britain before the arrival of the Romans. The ancient Britons obtained from Gaul a number of horses large enough for cavalry before Cæsar landed; they may also have obtained improved breeds of cattle — and large breeds were certainly introduced during the first century. Evidence of these we have in the skulls found during the excavation of Roman camps. For example, some of the skulls from Newstead belonged to cattle with horns twice the length and girth of the horns of the Celtic ox, and with limbs as strong as in the modern shorthorn. Some of the new breeds were probably brought from the Low Countries by the Tungri and Vangiones; some from between the Rhone and the Alps by the Vocontii; others from Germany and Gaul by the German and Gaulish auxiliaries. Whether the hornless cattle which left their remains at Bar Hill and Newstead were a polled variety of the British Celtic shorthorn or were introduced from the Continent, it is still impossible to say. After the Roman occupation of Britain came to an end at the middle of the fifth century, other breeds of cattle were introduced by the Teutonic and other invaders—and from the fifth century onwards the blending of various races and breeds has been proceeding almost without break or interruption to the present day. As the Jutes, Angles, Saxons, and others who came to settle in Britain usually entered by eastern ports, the new kinds of cattle were especially numerous along the eastern side of Britain; and as the new tribes extended their range, the original inhabitants, with their cattle and other belongings, were gradually driven in a westerly direction, or into the upland and more or less inaccessible areas. As the cattle from Germany and the Low Countries were chiefly of the urus type, the time eventually arrived when cattle of the Celtic shorthorn type occurred chiefly in the west and north, while the east and south were chiefly occupied by cattle of the urus type, the cattle in the intervening area being doubtless as a rule of a mixed type.

That oxen of the *B. primigenius* type were especially numerous along the east and south-east of England was generally recognized some generations ago. Amongst breeds said to be of the urus type were included the Chillingham, Teeswater, and Lincoln breeds; the Stafford, Derby, and other longhorn breeds; Hereford, Sussex, and Dorset breeds. While in the case of some of these breeds the resemblance to *B. primigenius* is not very obvious, there is no doubt that the Chillingham cattle in make and horns approach the urus. During the 13th century, herds of cattle roamed at will in the Caledonian Forest. From time to time detachments of the great Caledonian herd were enclosed, and gave rise to the Chillingham (Northumberland), Cadzow (Lanarkshire), Drumlanrig (Dumfriesshire), Naworth (Cumberland), and other herds. About the same time a number of white cattle derived from a southern herd were enclosed at Chartley (Staffordshire), and at subsequent periods herds were formed in Lancashire, Cheshire, Yorkshire, Northamptonshire, Nottinghamshire, Somersetshire, Perthshire, and other parts of England and Scotland.

It has been assumed by many that the white cattle which occurred in various parts of Britain during the 13th century were wild descendants of the urus herds which flourished in Britain during the Stone Age. But, as already indicated, there is no evidence that the urus survived in Britain up to the first century. Moreover, there is no evidence that the urus was white. From the fact that in the Chillingham, Chartley, and other herds coloured calves occasionally appear, the probability is that *B. primigenius* was either of a black or red colour. This view is supported by the fact that in the Chartley and other varieties the skin is often spotted. Further, in the Cadzow herd the cows were at one time often hornless, while in other herds (notably Lancashire, Cheshire, and Yorkshire herds) the bulls as well as the cows, though resembling the Chartley cattle in make and colour, were sometimes hornless. But though there is no evidence that the Chillingham, Chartley, Cadzow, and other white Park cattle are the direct descendants of the herds of urus hunted in Britain during the Stone Age, they indicate that for centuries Britain has possessed (in addition to crosses brought by the Romans, Jutes, Angles, and others) two nearly pure races, viz. the Celtic shorthorn (Owen's *B. longifrons*), and a race closely resembling in make the original urus or *B. primigenius*.

Whether in the polled cattle which have existed in Britain since the first century we have a third pure race it is difficult to say. The oldest ox we are acquainted with (*B. planifrons* of the late Miocene or early Pliocene) was hornless. If *B. primigenius* was a descendant of an ox of the planifrons type, it is conceivable that the Celtic shorthorn as well as the Chillingham and other less modified descendants of the original urus have once and again assumed the characters of the remote polled ancestor. By reversion, foals sometimes throw back towards their three-toed Miocene ancestors. If a structure of an extremely complex kind can be restored by reversion, a comparatively simple structure, such as a horn, may very well be lost by reversion. Hence perhaps in the hornless skulls from Roman and other deposits, and in the polled white cattle, we have probably not evidence of the existence of a polled race, but rather of reversion to remote hornless Miocene or early Pliocene ancestors.

How the shorthorn, longhorn, and polled modern breeds have been made it is very difficult to say. The modern shorthorn seems to be a blend of two pure breeds, one red and one white. Out of what varieties these red and white breeds are a blend, or how they were produced, history does not seem to relate; but from the results obtained by crossing it might be inferred modern shorthorns were originally derived from mating coloured bulls having small horns with white cows descended from, if not actually resembling, cattle of the Chillingham (urus) race. That some breeds with shorthorns include longhorned varieties amongst their ancestors is suggested by the history of Ayrshires. At one time Ayrshires had short horns of the Celtic type, but by selection the Ayrshires have been gradually provided with horns of the urus type. That modern polled breeds have in part descended from horned ancestors is suggested by the occasional appearance of calves with vestiges of horns. Were it desirable, it would probably be as easy to produce a horned variety of Galloway or of Aberdeen-Angus cattle, as it has been to make in America a polled variety of shorthorn cattle.

In addition to the descendants of the now extinct *B. indicus* and *B. primigenius*, the Bovidæ family includes: (1) the Buffaloes (*e.g.* the Anoa, *B. depressicornis*, of Celebes; the Indian Buffalo, *B. buffalus*; the African Buffaloes, *B. caffer*, *B. pumilus*, and *B. equinoctialis*); (2) the Bisons (*e.g.* the European Bison, *B. bison*, and the American Bison, *B. Americanus*); (3) the Yak of Tibet, *B. grunniens*; (4) the Gaur of India, *B. gaurus*; (5) the Gayal of Assam, &c., *B. frontalis*; and (6) the Banteng of Burma, Java, Bali, and Lombok, *B. sondaicus*.

[J. C. E.]

Cattle, British Breeds of.—Cattle are usually grouped according to their special aptitudes, and this system is adopted both on the Continent and in England. We are accustomed to regard cattle either as milk or as flesh producers, and but little attention is now bestowed upon working cattle. In Moll et Gayot's elaborate work, Connaissance du Bœuf, the same general classification is maintained, but much importance is attached to draught cattle. The three divisions include *les races laitières*, *les races de boucherie*, and *les races de trait*; and sections are also allotted to *races de montagne*, *races de plaines*, and *races de nature*. These latter find a counterpart in the British mountain races and wild cattle, but we scarcely possess a class which corresponds to the *races de plaines*. Many of our breeds of cattle unite milking and fattening properties in a marked degree, but the two qualities are to some extent antagonistic to each other. They are rarely seen existing in perfection in any one race, although it must be allowed that families possessing high milking properties may exist side by side with strains more given to beef production, although both may belong to the same breed.

Great Britain is particularly favoured in possessing many races of cattle, almost all of which have been improved by careful selection. The object of breeders has always been to produce the most valuable animal possible, and this could scarcely be realized if either milking properties or rapid fattening were neglected. The Shorthorn is an excellent example of high merit in both particulars, but there is an appreciable difference between the dairy Shorthorn and the type in which a disposition to lay on fat has been cultivated to an excessive degree. Shorthorn cows are capable of yielding large quantities of milk, and are regarded by many as unrivalled in this respect. Such cattle are in many cases of Shorthorn type without boasting of long pedigrees; but there are unquestionably cattle of the purest and longest lineage which possess traditionally deep-milking properties. We therefore place Shorthorns in both classes, as dairy cattle and as beef producers, and in this particular they are exceptional, if not unique. There are other cases in which a similar difficulty exists as to precise classification, as, for example, in the Norfolk Red Polls and Dexter Kerries. In order to meet this difficulty a separate class has been assigned to those breeds that possess in a notably high degree both milking and fattening properties. The following appears to be a practical classification, based upon the predominance of the leading qualities:—

Combined Beef and Dairy Breeds.

1. Shorthorns.
2. Lincoln Red Shorthorns.
3. Red Polls.

Beef Breeds.

1. Herefords.
2. Devons.
3. Sussex.
4. Longhorns.
5. Pembrokes and Castle-Martins.
6. Aberdeen-Angus.
7. Galloways.
8. West Highlanders.
9. Dexters.

Dairy Breeds.

1. Jerseys.
2. Guernseys.
3. Ayrshires.
4. Kerrys.
5. Dexters.

Forest and Mountain Breeds.

1. Wild White Cattle of Chillingham and other Parks.
2. Zetland or Shetland Cattle.
3. New Forest (Norman) Cattle.
4. Highland Cattle.
5. Welsh Cattle (unimproved).
6. Irish (mixed and unimproved).

It is stated on good authority that there are nineteen distinct breeds of British and Irish cattle, and about as many are represented in the above classification omitting those which occur twice, and the crossbreds, which cannot be considered to rank with pure breeds. See also art. CROSS BREEDS. [J. WR.]

Cattle, Fattening of. — Great strides have been made in the fattening of cattle during the last hundred and fifty years. Indeed the practice may be said to have come into existence during that period. Till the middle of the 18th century the only cattle that were fattened, with the exception of a few calves, were full-grown bullocks and old cows, the former of which had already spent a season or two in the plough, while the latter had fulfilled their function as suppliers of milk. Both were of an age but not of a kind to fatten readily, and, had they

been so, the feedingstuffs at the farmer's command were inadequate for the purpose, for they consisted only of hay of poor quality and straw either from beans or peas or from one or other of the usual grain crops. Grain was too valuable for other purposes, and consequently winter fattening of cattle was altogether impossible. Indeed, since it was something of a struggle to keep stock alive through the winter, the beef supply for the year was 'salted down' in autumn, and the cattle that were retained, being always in low condition on the advent of spring, had little opportunity to become fat ere the pastures died down for the year.

In the middle of the 18th century a number of circumstances combined to bring about a change. The growth of population and wealth created a larger demand for beef, and the discoveries of Jethro Tull and Lord Townshend supplied the farmer with a new winter feedingstuff. This new feedingstuff was the turnip, which had been introduced from the Low Countries by Sir Richard Weston about 1640, but which, being sown broadcast, made little headway till Tull's discoveries as to the advantages of drilling over broadcasting led Townshend to the further discovery that what was good for grain crops was still better for turnips. The only other necessity for the time was a better fattening animal, and this was forthcoming through the labours of Robert Bakewell, a Leicestershire farmer and grazier. Hitherto it had been the custom to turn the fat-inclined calves into veal and to retain the others for labour and milk, but Bakewell reversed the process. He retained the fat-inclined ones for breeding, and from his lead a large proportion of the cattle of the country were gradually turned from being slow and stiff to fatten, into animals that fattened readily and early. Eventually, on being displaced by the horse as an animal of draught, there remained but one function for the bullock, namely, to become fat.

Since Bakewell's time there have been other developments. Before the 18th century was out, two other root crops, swedes and mangels, and the oldest of our concentrated feedingstuffs, linseed cake, were introduced. Linseed cake, like turnips, had long been known in what we now call Belgium and Holland, but it became known in Britain only about the time the hydraulic press was invented. During the latter half of the 19th century, through the vast improvements in transit and communication and the fall in the price of grain, many new feedingstuffs were brought to the country, the most notable being cotton cake and Indian corn, and oats and other grain that formerly were too dear came within the farmer's reach for feeding and fattening purposes. At the same time the by-products from milling, brewing, and other industries increased greatly both in quantity and kind. Thus, while cattle had to be content with hay and straw till the middle of the 18th century, with hay or straw and turnips for another fifty years, with these and an occasional morsel of linseed cake till the middle of the 19th century, a remarkable change took place in their diet during the fifty or sixty years that have just gone by, the outstanding feature of which is the gradual displacement of the oldest feedingstuffs by others not only less bulky but more highly palatable and digestible.

At the same time, the vastly increased use of roots and concentrates was followed not only by an improvement in the quality of the beef produced, but also by a reduction of the age at which live stock were made ready for the butcher. Before the advent of the turnip, cattle were not sent to the butcher till they were full grown or even older, and, as already mentioned, since 'condition' could not be maintained upon hay and straw, fattening could take place only upon the pastures in summer. The addition of the turnip had the effect of staying the usual winter falling off, and, in the case of better animals, of continuing the fattening process into the winter; but it had little effect in decreasing the age at which stock were sent off to the butcher. All it did was to do what it does to-day when concentrated feedingstuffs are withheld, namely, to maintain the animal in the condition it had attained at the end of the pasture season. But with the addition of concentrated feedingstuffs a great change was accomplished, not only in reducing the age and improving the quality, but also in reducing the cost of producing the fattened animal. While hay and straw were the only foods, so much energy had to be expended in digesting these that little or nothing was left over to be stored up as muscle in the growing, or as fat in the full-grown animal; when turnips were added it became possible to store up some part of what was digested; but when concentrates were added to these, and the digestibility of the ration increased in consequence, it became possible to put muscle and bone upon the growing animal and to fatten him at the same time. A hundred and fifty years ago a bullock was made fat only after he was six or seven years old; now he is kept fat from his birth, and ready for sale at the first convenient and profitable opportunity. The need for 'storing' a bullock, in which there is about as much economy as carrying first-class passengers upon a sailing ship, or in keeping a horse for which there is nothing to do, has been abolished.

So long as the farmer's choice was confined to hay and one or two kinds of straw, and so long as his main consideration was merely to bring his stock through the winter, there was little room for speculation as to the relative merits of different kinds of fodder. Now, however, with foodstuffs increased in number, quality, and kind, there is ample room for the exercise of knowledge and judgment.

Bullocks are fattened off at ages varying between eighteen months and thirty-six, although the majority fall somewhere between twenty-four and thirty. Just as there is a difference between the previous treatment of a bullock to be fattened off at eighteen months and another to be fattened off at six-and-thirty, so also is there a difference, though smaller, between their fattening treatment. And just as some parts of the country, for reasons connected specially with their climate and com-

Experiments in Fattening Cattle

	I	II	III	IV	V	VI	VII	VIII	IX	X
	91 days.	84 days.	84 days.	84 days.	100 days.	100 days.	98 days.	98 days.	51 days.	84 days.
Foodstuffs—	lb.	lb.	lb.	lb.	lb.	lb.	lb.	lb.	lb.	lb.
Turnips	—	—	52	—	—	—	—	—	80	71·7[1]
Swedes	3·96[1]	—	—	—	56	56	90	90	—	37·6
Mangels	23·88	—	—	55	—	—	—	—	—	—
Sugar Beet	—	52	—	—	—	—	—	—	—	—
Hay[2]	6·57	10·5	12	11·5	4·51	4·56	3·07	3·18	—	—
Oat straw ..	—	—	—	—	4·51	4·56	3·07	3·18	6·1	8·0
Barley straw	2·96	—	—	—	—	—	—	—	—	—
Linseed cake	—	—	—	—	—	6·34	6·07	—	2·0	2·0
Decorticated cotton cake	—	—	—	—	3·17	—	—	6·07	—	—
Maize	—	—	—	—	3·17	—	—	—	—	—
Barley	—	—	—	—	—	—	—	—	1·0	—
Oats	2·78	—	—	—	—	—	—	—	1·0	2·0
Peas	—	6·6	6·5	6·5	—	—	—	—	—	—
Beans	3·64	—	—	—	—	—	—	—	—	—
Wheat	2·05	—	—	—	—	—	—	—	—	—
Bran	—	3·0	3·0	3·0	—	—	—	—	—	—
Wet grains	—	—	—	—	—	—	—	—	10·0	—
Approximately containing—										
Water	**27·17**	**47·63**	**49·86**	**52·87**	**52·16**	**52·12**	**82·06**	**82·00**	**81·23**	**99·59**
Solids (as under) ..	**18·60**	**24·37**	**23·14**	**23·63**	**19·20**	**19·80**	**20·51**	**20·41**	**18·86**	**21·87**
Albuminoids	2·71	3·48	3·19	3·43	2·88	3·26	3·45	3·82	2·35	2·39
Fats	·51	·51	·59	·61	·88	·96	·93	·99	·65	·65
Carbohydrates and fibre	14·38	18·99	17·97	17·99	14·32	14·24	14·78	14·24	14·71	17·60
Ash	1·00	1·39	1·39	1·60	1·12	1·34	1·35	1·36	1·15	1·28
	cwt qr. lb.	cwt.qr. lb.	cwt.qr. lb.	cwt.qr. lb.	cwt.qr. lb.	cwt.qr. lb.	cwt.qr. lb.	cwt.qr. lb.	cwt.qr. lb.	cwt.qr. lb.
Average weights of bullocks at beginning of experiment	11 1 23	9 1 23	9 1 25	9 1 27	7 0 22	6 3 26	8 0 15	8 0 22	7 3 1	7 2 9
Average weight at end	13 0 3	11 0 21	11 0 22	11 1 2	9 0 20	9 0 20	9 3 15	10 1 9	8 3 15	9 0 2[3]
	lb.	lb.	lb.	lb.	lb.	lb.	lb.	lb.	lb.	lb.
Average daily gain ..	**1·93**	**2·31**	**2·30**	**2·38**	**2·24**	**2·36**	**2·00**	**2·44**	**2·47**	**2·19**

[1] In these experiments the first-named root was given earlier in the experiment and the last-named later.
[2] In the first four experiments the character of the hay is not specified, in the next four the hay was composed of rye grass and clover.
[3] The bullocks in this experiment were walked some distance, and then carried 50 miles by rail before being weighed finally, and ½ cwt. is added to the weights they then showed.

mercial position, have taken to fattening the younger classes of bullocks, so other parts have taken to dealing with the older ones.

Bullocks that are to be fattened off at the younger ages are never 'stores' in the ordinary sense. They are well fed from their birth onwards, and always so near being ready for the butcher that the fattening process is merely a slightly more intensive continuation of the previous treatment. Most of them are calved during the winter months, and thus the oldest may be sold in June or July of the following year. For these the final fattening food is good young pasture and a mixture of from 2 to 3 lb. of linseed cake or decorticated cotton cake and crushed grain, the cotton cake being more suitable with succulent, and the linseed cake with drier pasture. Bullocks that are to be fattened off the pasture from the end of July to September need no concentrates till the pasture begins to fail in July, but from this time onwards they need an increasing and somewhat larger supply than those fattened off earlier.

Cattle of this class that are to be fattened before Christmas should have a small daily allowance of cake and corn during the last few weeks of pasturing, and they should be put under cover so soon as the weather becomes chilly. Otherwise they lose condition, which cannot be regained without time and expense. If it can be arranged, it is well that the transition from pasture to turnips and hay or straw be not too abrupt. Suitable foodstuffs for the transition are vetches or cabbages. When these are finished the ration approximates to 8 lb. of hay or oat straw or a mixture of both, 84 lb. of turnips or more, and 3 or 4 lb. of a mixture of decorticated cotton cake and crushed grain—the cattleman discriminating, of course, as to how much shall be allowed for larger or smaller appetites. During the last two or three weeks of fattening, many farmers substitute linseed cake for decorticated cotton cake, but this should be done gradually, and, with a large supply of roots, cautiously. For cattle of this age the turnips should be sliced or fingered.

The bulk of British cattle are 'stored' for a shorter or longer period, and fattened off at weights varying from 9 to 14 cwt. The lighter weights are mainly just under or just over two

years old, but among them there are many older cattle which have been reared and stored in an indifferent manner. The heavier weights are approximately three years old, and are drawn from the store districts on the West coast and from Ireland. Among these again are some animals that have received better treatment as stores, and are therefore better grown and in better condition.

It is with the lighter weights that most of our experiments have been conducted, and it will be profitable to consider these now and the lessons they teach. If we arrange a few experiments in tabular form the more important factors can be brought out. Experiment I was carried out by the Royal Agricultural Society of England in 1901–2; Experiments II, III, and IV by the Ontario Agricultural College in recent years; Experiments V, VI, VII, and VIII by the West of Scotland Agricultural College, Glasgow, in 1899 and 1900; and Experiments IX and X by the Agricultural Department of Aberdeen University in 1902 and 1904. In fattening experiments the quantities of the various foods supplied do not remain constant, but are varied throughout the experiment. In the table, therefore, the figures quoted are for the average quantities consumed per day throughout the experiments. Two or three of the experiments are not quoted exactly as reported by the experimenters: slight alterations having been made in order to eliminate factors that tended to detract from their value. In one experiment, for instance, all the figures attached to an unhealthy bullock have been removed. In the table on p. 142 it has not been thought necessary to indicate how the foodstuffs were treated before being fed, viz. whether the roots were sliced, the grain or cake ground, or the hay and straw chopped. It must be remembered also that, because of the difficulty of weighing roots and long fodder—the latter especially—some of the weights quoted must be regarded as approximations.

Considering the constancy of the chemical composition of the rations and the daily increases of the experimented animals, it might be said that a fattening bullock gaining slightly over 2 lb. a day should have a daily ration containing about 3 lb. of albuminoids, from ½ to ¾ lb. of fat, and from 15 to 18 lb. of carbohydrates and fibre together. But such a direction would be neither intelligible nor useful to the farmer. By condensing the table slightly, its main features can be made plainer, and a much simpler statement obtained:—

The Above Table Condensed

	I	II	III	IV	V	VI	VII	VIII	IX	X
	lb.	lb.	lb.	lb.	lb.	lb.	lb.	lb.	lb.	lb.
Roots	27 84	52	52	55	56	56	90	90	90	109·3
Long fodder ..	9·53	10·50	12	11·5	9·02	9·12	6 14	6·36	6·10	8·00
Concentrates	8·47	9·5	9·5	9·5	6·34	6·34	6·07	6·07	4·0	4·0
Containing										
Water . ..	27·17	47·63	49·86	52·87	52·16	52·12	82·06	82·00	81·23	99·59
Solida	18·60	24·37	23·14	23·63	19·20	19·80	20·51	20·41	18·86	21·87
Daily gain	1·93	2·31	2·30	2·38	2·24	2·36	2·00	2·44	2·47	2·19

Thus a fattening bullock of the kind dealt with in the experiments, making slightly over 2 lb. a day, requires from ½ to 1 cwt. of roots, from 9 to 4 lb. of concentrates, and as much hay or straw as he cares to consume. It will be seen that the three main constituents, especially roots and concentrates, may vary considerably, and that, the decline of one or two of them may be made good by the rise of both or one of the others, provided always that roots and concentrates are sufficient to prevent the animal having to depend upon the far more indigestible hay or straw, in which case he and his owner are no better off than their predecessors of a hundred years ago. The important factors in a ration are digestibility, succulency, and palatability, as well as the total quantity of solids — all which are furnished by roots and concentrates, and by these being given in quantity sufficient to neutralize the indigestibility of hay or straw. Albuminoids and fats are necessary, of course, but in an ordinarily well-compounded ration these are always present in more than sufficient quantity. Indeed the question for future research is rather how far they may be reduced —the albuminoids especially—and replaced by the cheaper and more economical carbohydrates.

The practice in successful cattle fattening varies in unison with the experiments quoted above, the variations running in line with the available supplies of long fodder and roots. In parts of the country where oats and turnips and swedes are the predominant crops, and where the straw and roots are consumed by cattle, the practice with cattle fattening off at 10 to 12 cwt. is to give a full supply of roots—84 to 112 lb.—a smaller supply of concentrates—3 to 5 lb.—and oat straw as required. The mainstay of the concentrates is now decorticated cotton cake, which with these large quantities of roots is more satisfactory than linseed cake. But it is usual to give an equal quantity of grain—oats, barley, or maize — or some by-product, as for instance dried grains, which can be bought upon better terms. In barley or wheat or potato districts where the supply of edible straw is shorter, or where it is customary to feed off a portion of the turnips with sheep, it is common

to give a larger helping of concentrates to make up for the shortness of roots and the shortness and indigestibility of the long fodder. In parts of the country where less land is tilled, meadow hay takes the place of oat straw, and the shortness of roots is compensated for by an increased supply of concentrates.

Fattening of the older and larger classes of cattle—the animals about three years old that have been 'stored' in the west of Britain and in Ireland, and that are fattened off at 11 to 13 or 14 cwt.—is confined mainly to those parts of the east coast where tillage is most intense—to such counties as Forfar and the Lothians, East Yorkshire, Lincoln, and Norfolk—and their treatment differs from that of the smaller animals in that their food is increased by 15 to 20 per cent and contains a larger proportion of straw from barley and wheat.

The following might be quoted as typical though not extreme rations for both classes of cattle, one for each class containing a larger, and the other a smaller supply of roots:—

DAILY RATIONS FOR SMALLER CATTLE

	I		II
	lb.		lb.
Roots	98	......	56
Decorticated cotton cake	2	......	4
Crushed oats or other grain or by-product	2	......	4
Oat straw as required, say	7	......	8

FOR LARGER CATTLE

	III		IV
	lb.		lb.
Roots	126	......	70
Decorticated cotton cake	2	......	4
Crushed oats or other grain or by-product	2	......	4
Straw as required, say ...	8	......	9

it being understood that there are all kinds of gradations between and outside these rations, and that as fattening proceeds the concentrates are gradually increased from slightly below the figures quoted to slightly above them.

Besides the choice of foods there are other factors of equal importance in cattle fattening. It is desirable to increase the palatability and digestibility of foodstuffs in order not only to increase their consumption but also to make them go farther. In the matter of palatability very little can be done, unless it be to mix up the more unpalatable foods with the others, or to add to them some special constituent such as treacle. As regards digestibility, more can be done. The straw can be chopped and the grain crushed or ground; but it is questionable whether what is gained in digestibility by chopping is not lost in palatability unless the chopping be performed daily. But of still greater importance are quietness, comfort, and regular feeding—factors depending almost entirely upon the efficiency of the cattleman.

It would be difficult to insist too strongly upon regular feeding. It is of no great moment whether animals are fed three times or thirty times a day; but it is of great importance that they be always fed at the same time, and that other necessary operations create as little disturbance as possible. The stall should be cleaned out and fresh litter spread while the roots are being eaten, and thus feeding and cleaning are one disturbance instead of two, while the animal may lie down in comfort immediately feeding is over. Cattle should be groomed every other day at least, for this is no disturbance to cattle that are treated kindly, but rather a cause of contentment, and therefore of the production of fat. The following might be suggested as a cattleman's time table:—

6 a.m.—Feed one half the roots and give fresh fodder immediately after. Clean out the stalls and spread fresh litter.
10.30 a.m.—Feed one half the concentrates.
3 p.m. to 4 p.m.—Groom half the cattle.
4 p.m.—Feed the other half of the roots and give fresh fodder.
5.30 p.m.—Feed the other half of the concentrates.
8 p.m. — Look round the byres and shake up displaced litter.

There remains to be discussed the question of profits. Is it profitable to fatten cattle? To that question many answers are given, many of them being either doubtful or inclined to the negative. Yet the fattening of cattle increases, a fact suggesting that the process is either profitable or carried on at a loss in order to make a profit out of something else. The truth lies really in both these answers, but in order to ascertain it there must be an exhaustive reckoning of expenditure and income. But before this can be done we must determine the basis upon which home-grown feedingstuffs are to be valued.

The prices of concentrated feedingstuffs and grain can be ascertained readily, but not so with roots and fodder. True, there are markets for these in populous districts, but the great bulk of our roots and long fodder is grown so far away that it is excluded from a profitable market by the cost of transport, and in consequence must be turned into beef or some other transport-bearing commodity. It is not unusual to estimate the value of roots by their cost of production, but this is no more fair for them than for anything else for which there is no real market; and since one man may raise them for 5*s.* or 6*s.* a ton, while another may not do so under 10*s.* or 12*s.*, it would be no simple matter to strike an average upon this basis, even assuming that the average cost of production represents the average value, which is by no means the case in other articles of commerce. Attempts have also been made to place a price upon roots by subtracting from the price of the beef produced the price of the other foodstuffs used in its production, and placing the balance to the credit of the roots; but here again, as is to be expected, very different figures have been obtained, since items like profit, interest, risks, and expenses of management have usually been omitted from the estimates.

There are, however, two criteria from which, without neglecting values obtained by the foregoing methods, reasonably fair estimates may be obtained. *First:* In many parts of the country where cattle are fattened it is usual to let turnips for consumption on the field by sheep, in which case the return to the farmer runs to

somewhere between 7*s.* and 9*s.* a ton, and this too for roots that are usually neither pulled nor carted to a store. *Second:* On referring to the table of experiments it will be seen that the solids in roots and concentrates may replace each other to a very considerable degree. That being so, the solids in each, or at any rate their proximate constituents, may be set down at nearly the same value. Valuing the proximate constituents in concentrates by the same method as that adopted for valuing artificial manures, and transferring the values obtained to roots, it is found that, due consideration being given to the extra cost of handling, to the superfluous water, and to the unmarketability of roots, their value comes out about a shilling per unit of solids per ton; roughly 9*s.* to 11*s.* or 12*s.* a ton according as their solids run from 9 to 11 or 12 per cent. Thus if we value turnips and swedes at about 9*s.* a ton, we shall not be very far below and certainly not too far above the upper and lower limits. Luckily there are far more frequent sales of hay and straw, and we may take their average price in fattening districts to be approximately 60*s.* for rye grass and clover hay, 50*s.* for meadow hay, 40*s.* for oat straw, and 20*s.* to 25*s.* for barley straw and wheat straw. In the matter of concentrates it will be well to assume the average prices over the last few years.

To bring out the profits from fattening in general, let us take the four cases quoted upon page 144, and assume fattening to be accomplished on the average in ninety days:—

Daily Cost of Fattening Bullocks

	I		II		III		IV	
		£ s. d.		£ s. d.		£ s. d.		£ s. d.
Roots	$78\frac{3}{4}$ cwt...	1 15 6	45 cwt. ...	1 0 3	$101\frac{3}{4}$ cwt..	2 5 9	$56\frac{1}{4}$ cwt...	1 5 4
Decorticated cotton cake	180 lb.	0 11 6	360 lb.	1 3 0	180 lb.	0 11 6	360 lb.	1 3 0
Crushed oats ...	180 ,, ...	0 8 6	360 ,, ...	0 17 0	180 ,, ...	0 8 6	360 ,, ...	0 17 0
Oat straw	45 st.	0 11 3	$51\frac{1}{2}$ st......	0 13 0	$51\frac{1}{2}$ st.	0 13 0	58 st.	0 14 6
Litter	4 cwt.	0 5 0	4 cwt.	0 5 0	4 cwt.	0 5 0	4 cwt.	0 5 0
Attendance		0 7 6		0 7 6		0 7 6		0 7 6
		3 19 3		4 5 9		4 11 3		4 12 4
Less value of manure ...		0 12 0		0 12 6		0 12 6		0 13 0
		3 7 3		3 13 3		3 18 9		3 19 4
Approximately per day		9*d.*		$9\frac{1}{2}$*d.*		$10\frac{1}{2}$*d.*		$10\frac{1}{2}$*d.*

Thus, if food and attendance cost say 9*d.* a day for smaller, and 10*d.* for somewhat larger cattle, and if these increase $2\frac{1}{4}$ and $2\frac{1}{2}$ lb. respectively per day, then, in order to pay merely for food and attendance, the increase must be sold at 4*d.* a lb. live weight. But 4*d.* a lb. means 37*s.* 4*d.* a cwt., which is equal for the fasted cwt. to 39*s.* 4*d.* for animals weighing 10 cwt., and 38*s.* 9*d.* for those weighing 13 cwt., prices which may be obtained occasionally but not regularly. Thus, from this point of view there is no profit in fattening cattle. Indeed there is a loss of 10*s.* on every animal weighing 10 cwt., and 13*s.* on every animal weighing 13 cwt., for every shilling the price falls below 39*s.* 4*d.* in one case and 38*s.* 9*d.* in the other; with corresponding gains of course, when prices run in the opposite direction.

But there is another aspect of the question. Cattle to be fattened are usually bought in at from 5*s.* to 10*s.* a hundredweight less than the price at which they are sold when fattened, and every shilling added to every hundredweight of the original weight is a contribution towards the accumulation of a profit. A bullock weighing $8\frac{1}{2}$ cwt., bought in at 34*s.* 4*d.* a hundredweight and fattened for 9*d.* a day to the value of 39*s.* 4*d.* a hundredweight, leaves £2, 2*s.* 6*d.* (5*s.* × $8\frac{1}{2}$ cwt.) in the farmer's hands to set against risk, interest, marketing expenses, and profits; another bought in for 29*s.* 4*d.* leaves £4, 5*s.* (10*s.* × $8\frac{1}{2}$ cwt.), and so on.

Assuming reasonably good judgment as to the type of animal to be fattened, and as to the conduct of the fattening process, the question of profit turns mainly upon three factors, viz. the buying-in price, the selling-out price, and the price of the necessary foodstuffs. The last being, perhaps, the most constant factor, then the wider the gap between the prices of the store and the fattened animal the higher the profits. But it must never be forgotten that the base from which the farmer starts to earn a profit in fattening cattle is the vigorous and economical production of turnips and straw. See also arts. Fattening of Farm Stock, Early Maturity, &c. [J. Wi.]

Cattle, Feeding and Management of Young.—Much depends upon the season of the year in which the animals are born; that is the precise age at which winter feeding is commenced. Calves dropped later than the end of August should not be turned out to grass until the following May or June, or at six to nine months old. Such calves generally do well, as they have a start over spring calves. Calves may be weaned at any time, but all months from September to March are excellent. Such calves will be turned out to a pasture near the homestead the following summer, and will be better of 1 or 2 lb. of linseed cake per head per day. A hovel or shed should be provided, and they should have access to water. This, with supervision, sums up the management during the

first summer, with the exception of such changes of pasture as may be found necessary. If the young animals are intended for the dairy, or for growing into steers for fattening, there is no advantage in adopting a more forcing system, and it is not the intention at present to describe the feeding of animals intended for exhibition, or for the production of 'baby beef'. Even the leading breeders of pedigree stock always recommend a natural method of treatment for young stock and also for cows, and rely upon exercise, natural food, and plenty of pure water as essentials. The management of high-class pedigree stock ought not to vary from these principles, except in closer supervision, and it is a libel upon pedigree animals to state that they are more delicate or less frugal than unpedigreed animals. If such is the case, the main objects of breeding have evidently failed, as they include robustness of constitution and superior powers of assimilation. Much also depends upon the future prospects of young stock, as, for example, whether they are ultimately to be turned out on high-lying pastures or woodland grazings, or to live a shorter life on rich land. In fact, young stock, like children, should be brought up for the life before them. As it is the boast of our leading Shorthorn breeders that their cows live hard and mostly out-of-doors, it is evident that calves and yearlings should not be pampered, either as regards food or shelter. The life of calves during their first summer is therefore simple, and does not allow of prolix remarks, as though it were a highly complicated process. These young cattle should not be allowed to remain too late on grass, but should be brought into yards in October or November, according to the character of the season. They are in many localities liable to contract husk or hoose (see HUSK) after the grass loses its nature and the nights become cold, and are therefore housed several weeks earlier than yearlings or two-year-olds.

The first, or in the case of the older calves the second, winter is the most critical period of their lives. They should be divided into two lots, the first composed of the bigger calves, which are then approaching one year old, and the second division should include the smaller calves, which are only about six months old. The older lot may be sent into straw yard at a distance, but the smaller calves require better shelter and feeding, and should be provided with a small yard at the homestead, where they can be more constantly attended upon. As to the food during the first winter, roots, hay, and 2 to 3 lb. of linseed cake form a suitable dietary. They must be well supplied with water, and one class of food at least should be allowed *ad libitum.* If such animals have 3 lb. of linseed cake, or 1½ lb. each of cake and meal, with 15 lb. of roots, and hay *ad lib.*, they will do well. It is important that the food should be given regularly, and not so as to surfeit or destroy the appetite. The animals should present a healthy appearance in their coats and faces, and should not become hidebound or paunchy. About the latter end of April they may be turned out upon ordinary rough pasture without any extra food, and remain out till December. In some places they are out all the winter, but on the whole they are better brought into yards before the advent of severe weather.

We now come to the second winter, *i.e.*, in the case of calves born in spring, when the young cattle are from one and a half to two years old. They are at a hardy age, and will do well on straw, mangel, and about 4 lb. of ordinary cotton cake. This cake is not suitable for younger cattle, but may now be given without hesitation. They should be fed twice a day, and always have straw and water before them. The heifers intended for cows should be bulled at from twenty-one to twenty-four months old. Some breeders prefer them to take season at fifteen to eighteen months old, but the result is often seen in deficient frames. Much depends upon the system of feeding followed, but on moderate food and rough pasture three years old is a good age for a heifer to produce her first calf. This means taking season at twenty-seven months old. The third summer in all respects resembles the previous one, and there is nothing to add to what has already been said. At the end of it the cattle will be from two to two and a half years old, and may be in-calvers or steers ready for fattening. They may therefore be considered to have been brought up, and to have passed out of the present connection.

FOODS MOST SUITABLE FOR YOUNG STOCK.—In the above sketch the writer has endeavoured to present the case of ordinary management as carried out upon mixed arable farms. He has neither attempted to describe the life of calves dropped on the hillside and brought up innocent of artificial food, or the career of young bulls, or of steers intended for the butcher at fourteen months old. There are establishments in which more complicated systems are employed than have been indicated, based upon more scientific principles. So far as grazing is concerned there is no room for improvement, except in supplementing any natural deficiencies which may occur. In grass the nutrient constituents are perfectly combined, but in the yards, during winter, scientific feeding is quite possible. One of the leading principles in feeding is that growing animals require albuminous constituents in their food to a greater degree than mature animals. Milk possesses a high albuminoid ratio, and is in many cases continued up to a year old. One of the best nitrogenous foods suitable for young animals is linseed cake, which may be employed at the earliest stage. After a year old, cotton cake may be substituted, either rough or decorticated. Bean and pea meal, malt culms, and clover hay are also suitable for growing stock. An excess of albuminoid food is, however, liable to produce stiffness of the joints and shoulders, due to a form of albuminoid poisoning. Feeding ought to be moderate and varied, and the animals should have every opportunity for exercise. In many places the system is more complicated on account of the introduction of chaff cutting, root pulping, and steaming boilers. A couch of sweet cut straw is rendered both pala-

table and nutritious by baling over it a boilerful of linseed mucilage and mixing up the mass. It is, however, noticeable that these refinements are mostly confined to elaborate buildings beyond the income of tenant farmers. Besides, they have never enlisted any strong opinions in their favour. Dry chaff, well mixed with meal and a few pulped roots, seems to be equally attractive with boiled up or steamed messes, which are only too liable to become fusty. The use of the chaff-cutter and pulper is general, but cooking, boiling, and steaming may as a rule be dispensed with. The writer has noticed in several cases where the necessary apparatus has been provided that it is not used.

Accommodation for Young Stock.—As already indicated, young stock are best in the open air. At such times of the year as they seek winter quarters, roomy and well-shedded yards are very suitable. Young cattle should not either be tied up by the neck or confined in boxes. There is no objection to covered yards, but they are not so good for the animals as exposure to the elements. They economize litter, it is true, but young animals housed in them should be allowed to run out into a pasture during the day.

Early Maturity.—It is possible to fatten young animals from birth. This is commonly done with porkers and lambs, these animals never being allowed to lose their birth condition. In the case of calves, the result either takes the form of veal or of baby-beef. In many circumstances the system is sound and profitable. An animal should, it is said, never lose its calf flesh, and applying the same principle to lambs they are in numerous cases fatted off at ten months old as tegs. Growth is never interrupted, and proceeds very rapidly. The animals always weigh well, and the quality of the meat is first-class. In the case of calves, the dams selected may be of hardy origin, such as Irish or Galloways, and these are mated with a good Shorthorn bull, and drop their calves early in the season. The calves are allowed to suck their dams, and are encouraged to eat cake, meal, and roots. The cows, or rather heifers, are also well supplied with good fattening food, and in thirteen to fourteen months a pair of fat animals, worth probably about £30, is the result, although the heifer when originally purchased probably only cost £6 or £7.

Specializing of Breeding Stock.—In these days many dairy farmers make a point of selling every calf as soon as it is dropped, and most winter graziers purchase stores for fattening at £12 to £13 each. The reason for thus shelving the whole question of rearing is the specializing of the land to a particular purpose. The milk seller will not wean calves, and the grazier will not rear them, and the consequence is dear stock, and an outcry for Canadian stores. In other cases a system is followed which is more consistent with the gradual improvement of a herd of cows. A first-rate bull is kept, and a sufficient number of heifers are weaned, and eventually come into the dairy of cows. Everything depends upon the land, and some districts produce milk, others fatten bullocks, and others again raise young stock. The greatest cattle-raising districts are found in the Highlands of Scotland, Dumfries, Galloway, in the west of England, and in Wales. [J. Wr.]

Cattle, Statistics of. — In its total stock of cattle the United Kingdom compares favourably with its position when the first comprehensive agricultural statistics were collected forty years ago. The numbers shown in 1867 were 8,700,000 head: on the average of the past three years the total has been 11,700,000. This gain of 34 per cent, or 3,000,000 head of cattle, is a material counterpoise to the loss of 3,000,000 ac. of corn in the same interval; and its effect on the meat supply is even greater than the figures themselves suggest, for the improved quality of the stock and their earlier maturity tend to make a larger aggregate weight of beef now available. Computed as an asset in the farming capital of the country the present stock of cattle can hardly be worth less than £120,000,000. Reckoned on the measured surface of the country, the United Kingdom now carries something like 150 head of cattle on each 1000 ac. as against only 112 head in 1867. Restricting the comparison to the acres of so-called cultivated land, whether under grass or crop, the cattle stock of 1907 is 247 head to the 1000 ac. compared with a density of only 191 forty years before. The comparison ceases to be favourable if we take account of the yet more rapidly increasing population of meat consumers. For each 1000 persons in 1867 there were 290 cattle kept in these islands, and even something over 300 head in 1873–7, whereas now, when the population exceeds 44,000,000 persons, even our larger herds represent but 266 head of cattle to each 1000 of our inhabitants. Moreover, the consumption of meat by each unit of the population is greater now than it was, and compels increasing reliance on the cattle of other countries by the importation of live cattle from abroad for slaughter in our ports, and, still more largely, of a growing quota of fresh chilled or frozen beef. It has been calculated by the best authorities that something over 3,000,000 head of cattle (including in that number 900,000 calves) are annually furnished to our food supply by the native herds of this country, while recently our imports of live cattle have averaged 530,000 head per annum, and the beef imports in other forms represented the produce of nearly another million of cattle slaughtered abroad for our consumption here. The dimensions of these auxiliary supplies, their ratio per head, and the recently stationary character of the imports of live cattle compared with the rapid development of the dead-meat trade, may be traced in the statistics offered elsewhere. See Beef, Statistics of, and Dead Meat Trade.

Although the increased stock of cattle maintained by our British agricultural system has not sufficed to meet the formidable growth of the numbers of our people and their larger use of beef as food, the United Kingdom nevertheless rears more cattle on a given area of surface than its European neighbours, if such small States as Belgium, Holland, or Denmark be

excepted. For each 1000 ac. of total area France shows but 108 head of cattle, Austria 128, and Germany 145, and this comparison with the 150 head maintained on a similar area in the United Kingdom is the more noteworthy when the rare use of cattle here for farm labour is remembered, and their frequent employment on the Continent. Our cattle stocks have also been developed here without our suffering anything like the remarkable reductions in their flocks of sheep by which the increase in the cattle of Continental countries has been accompanied.

The density of the cattle maintained in any country of necessity depends largely on its physical conditions, and there is of course much variety in this respect between different parts of the United Kingdom itself. Our average of 150 head to 1000 ac. of territory is the mean of widely different ratios. It thus covers a proportion of 226 cattle to 1000 ac. in Ireland, whence Great Britain has drawn more than 700,000 cattle annually in recent years, and includes as low a density as 62 in Scotland or 98 in the eastern group of English counties. The statistics of individual counties would moreover show that, given like conditions, we can show a larger head of cattle than even the three smaller European States whose average exceeds our own. Thus Cheshire or Leicestershire carry more stock than Belgium, where 245 to the 1000 ac. have been claimed; Cornwall or Somerset exceed the 210 of Holland; and Derby, Stafford, or Shropshire have more than the 194 per 1000 credited to Denmark. The British cattle enjoy also a pre-eminence of quality which has secured to us a very special and important trade in the export of pedigree stock, for notwithstanding the importations we receive, mainly from transatlantic sources, our growing export trade in cattle reached in 1906 a total value of over £327,000, and represented twice the average exports of the five preceding years. Both the skill of our breeders in this country and the beneficial effect of the successful suppression of imported cattle diseases in the United Kingdom have contributed to give this country a paramount position of superiority in supplying the best types of stock required by countries in which the industry of cattle-breeding is being now pursued.

An analysis in detail of the composition of our herds shows that at the present time the cattle of the United Kingdom include a herd of 4,338,000 cows or heifers in milk or in calf (80 per cent of these being 'in milk' at the time of enumeration in June, 1907), while the remaining stock are grouped in three classes of very nearly equal dimensions. Under one year old there were 2,407,000 head, of one year and under two there were 2,449,000, and the cattle of greater age than this were 2,434,000 in number; but these proportions vary widely in particular districts. In Great Britain by itself the cows may form on the average 40 per cent of the herd, and in the north-western group of English counties the proportion may reach 50 per cent, whereas in Ireland the cows seem to form only 33 per cent, and in the east of Scotland little more than 25 per cent of the whole. Features such as these, not only in international comparisons but in any investigation into the interdependence of various districts of the country, require to be remembered in any computations of the relative importance of the cattle-raising industry in particular districts, whether the stock are kept for the sale of stores, fattening for meat, or for dairy purposes.

As a whole, it is to be remembered in this connection that the cattle of the United Kingdom are not only computed to provide some 680,000 tons weight of beef and veal annually, but likewise an aggregate of over 1,720,000,000 gal. of milk, which reaches consumption either directly or in various manufactured forms. The conclusions of a recent committee of the Royal Statistical Society place the share of the domestic herds of this country in the food supply at 63 per cent of all the beef and veal, 47 per cent of the butter, 35 per cent of the cheese, and practically all the milk directly consumed in this country. [P. G. C.]

Cattle-breeding.—Cattle-breeding is a pursuit or business which has been systematically followed in this country during the last 150 years at least. During this period all our 'improved' races have come into existence from the Longhorn and Shorthorn cattle and new Leicester sheep, which arose under the genius of Bakewell, the brothers Colling, Bates, and Booth, and an army of enthusiastic breeders; onward, until every breed of live stock in the country had been subjected to the same rigorous system of selection and weeding.

The movement thus inaugurated has been continued with marvellous success, and is still in progress. It is worthy of remark that the results achieved were not due to physiological study nor even to anatomical knowledge, and that later scientific views and hypotheses have been largely founded upon the results of practical breeders, who were themselves guided by principles much more easily grasped by the unscientific mind. These leading ideas were, that 'like produces like', and that descent from truly bred parents is the best guarantee for fixity of type. The principal objects aimed at were early maturity, economy in food, the maintenance of constitution, and of beauty and utility of form, all of which were secured by adherence to the two ideas first mentioned. Probably, even at the present day, few breeders care to travel far beyond these principles. They were accompanied, in the case of all the earlier pioneers, by a fearless application of the system of in-and-in breeding, for the obvious reason that it was difficult to find sires or dams of the requisite merits, which were not nearly related. The limitation of breeding to certain strains or families which were found to possess desirable qualities accentuated the necessity for close breeding, and the success of the system was the best proof of its soundness. There has no doubt been a reaction, so that in our day the prejudice against close breeding is very general, and non-related parents are thought by many to be essential to continued success. Cattle and other gregarious ruminants, however, seem to

be inured to close breeding by their natural habits; but the assurance of success lies in the perfect soundness of the parents themselves, irrespective of relationship. Any predisposition to disease is sure to be intensified by close affinity in blood, as both parents transmit the same tendencies. On the other hand, strength of constitution and beauty of form, colour, and other qualities aimed at, are more likely to be reproduced in the case of offspring from parents possessing such properties, even if closely related, on account of the principle of atavism, or the effect of remote ancestry upon immediate progeny.

The art of cattle-breeding consists to a great extent in the selection of parents, and it may be said without fear of contradiction that, except in the judicious mating of animals, there is little difference between the management of a high-class herd and one of ordinary cattle having no pretensions to special excellence. If the annals of successful cattle-breeders are studied, it will be found that all are agreed that pedigree cattle ought not to be pampered either as regards food or shelter. The cows and young stock are to be kept in the open air, and to receive ordinary food in the form of pasturage, hay, roots, &c., like other cattle. It would, in fact, rather prove inferiority than the reverse, if high-bred cattle required better food and housing than others. Their high individual value naturally renders them the object of much solicitude, but this is consistent with ordinary management, accompanied with a higher degree of care and watchfulness.

The selection of a sire, or series of sires, becomes the principal point in maintaining a herd; and in this selection the pedigree of the bull must harmonize with that of the sires previously employed. The value of an established herd would soon deteriorate if discordant elements were introduced by a series of inferior sires or even of unrelated strains. Hence the endeavour to preserve a harmonious pedigree by employing sires of similar blood, and thus ensuring purely bred young stock, and a 'paper pedigree' which will stand scrutiny. It is true that there are breeders who have fearlessly mixed strains of blood, and relied entirely upon personal excellence; but it is a critical experiment, as the introduction of a single discordant cross in a pedigree will be quickly discovered, and may cause the retirement of buyers round a sale ring, who otherwise would be prepared to give high prices. The importance of pure lineage on both sides, coupled with personal excellence, are the two principal points in high-class cattle-breeding. The management, as already indicated, is of ordinary character; and if the animals are better fleshed, larger, and handsomer than other cattle, it is due to their inherent excellence, and not to pampering. The case of animals preparing for exhibition is entirely different, and every care is used in order to bring them to the highest state of perfection. But, so far as the store stock and cows are concerned, they ought to be able to stand exposure and hard keep as well as, or better than, badly bred cattle.

Cattle-breeding forms a department of mixed husbandry, and is naturally associated with dairy farming. It is not, however, by any means the invariable practice to wean calves, and in many dairy districts the markets are thronged with these young creatures from one week old and upwards. The object is the sale of milk, and it is thought better to sell the calves as soon as possible. The best heifer calves are bought for weaning, but the bull calves are either slaughtered for veal, or castrated, weaned, and kept for steers. A herd of cows does not therefore always imply cattle-breeding. The land is, in many cases, too valuable to be employed in growing young stock, as may be seen in the well-known dairy districts of North Wilts, where very few calves are weaned. The same is true in many other localities, where, in the case of herds numbering sixty to eighty cows, no calves are saved. In Wilts the calves are sold into Oxfordshire, and are returned into Wiltshire as 'down-calvers', and find a ready market.

Cattle-breeding may be divided into three different systems, according to the objects of the breeders: (1) There is the raising of pedigree stock, answerable for all the herd-book societies, and, largely, for the existence of cattle shows. This system has been already explained, but is worthy of further reference because to many it must appear as 'breeding' *par excellence*. It would, however, be a mistake to imagine that the breeding of pedigree cattle is not rather exceptional than general. (2) On mixed farms it is recommended to raise enough stock to replenish the dairy, and fill the cattle stalls. The open market is, however, largely relied upon for these purposes, as quicker, and sometimes cheaper. Still, it is evident that no gradual improvement of a dairy can take place excepting by the successive use of high-bred sires upon a good foundation, and this system is in fact largely followed by many who do not aspire to be breeders of pedigree stock. (3) There are large districts in the west and the north which are naturally adapted for breeding both cattle and sheep. In these islands the country rises into mountainous tracts in those directions at every point—as, for example, towards Devon and Cornwall; South and North Wales; Derbyshire, Stafford, and Hereford; Lancashire, Yorkshire, Westmorland, and Cumberland. The same rule holds good as to Scotland, so that the principal sources of store cattle are found in the west of England, in Wales, and in north and west Scotland. The black cattle of Aberdeen and of Galloway; the West Highlanders; the Shorthorns from the Lake districts; enormous droves of Hereford and Devon cattle from the west; Welsh runts and Pembrokes from Cambria, and mobs of Irish cattle of mixed character which cross the Channel and are distributed through the grazing districts—these, as well as the surplus cattle bred in favourable situations, supply our markets with store stock.

Cattle-breeding is therefore extensively carried on by all of the three systems above enumerated. In the first it is a highly scientific pursuit,

requiring much study of pedigrees and points. In the second it is less ambitious, and aims at a good and improving stock. In the third it is often distinct from either high-class breeding or dairying. The calves are dropped on the open hillsides, and suckle dams which are never milked. Milk production is lost sight of, and the consequence is that the breeds used for this purpose are considered to be poor milkers, and only fit to rear their calves. Pedigree breeding requires good land, large capital, and natural love (genius) for the pursuit. Dairying, combined with the improvement of large herds, involves much judgment and skill. On the other hand, the mere raising of cattle for sale as stores is associated with wide tracts of poor and hilly land, in which the cattle are left in a great measure to themselves, with the minimum of artificial help.

There is no department connected with agriculture more worthy of attention than cattle-breeding, and it is a matter of regret that so many calves are sacrificed at an early age. Hitherto, and for the best possible reasons, the importation of foreign stores has been restricted as dangerous to the health of our home stock. This ought to encourage home breeding, and no doubt does so, but among graziers the high price of store stock is an old-standing cause of complaint. One solution, which appears to be a very practical one, is to breed the necessary stock at home; but it is often forgotten that the same land which is highly favourable for winter fattening may not offer facilities for maintaining young stock; and that the land which is most suitable for summer grazing is too good for depasturing with stores. See also arts. BREEDING, LAWS OF; ATAVISM; TELEGONY; MENDELISM; FARMING, SYSTEMS OF. [J. WR.]

Cattleman's Duties.—The cattleman is responsible for the wellbeing of his herd, and it is his duty to see that they are properly housed and fed, and are maintained in a clean and thriving condition.

The cattleman begins his work about 5.30 a.m. by dealing out a meal of turnips to the cattle. While these are being consumed, the byre is cleaned out and clean litter supplied. A fresh supply of straw is afterwards given, and the first duty of the day is over. Where the young cattle are kept in a covered court, the litter is not removed, but is trampled down, and the turnips are sliced instead of being fed whole.

The next ration is generally given about ten o'clock, the interval between times being occupied by the cattleman in performing minor duties, such as breaking feeding cakes, cooking foodstuffs, and attending to the proper ventilation of the byre. If a pedigree stock is kept, the young bulls may be trained to lead, and the stock bulls exercised. At this ration, concentrated foodstuffs in the shape of meals or bruised cake are supplied, either in the dry form, or as a mash with treacle, combings, and chaff. A foddering of hay or straw is given in addition, and any fresh dung drawn into the dung channel. At this time the young cattle receive half their daily allowance of concentrated foodstuffs. Between this time and the afternoon the cattle are groomed. An occasional washing with carbolic soap or a non-poisonous sheep dip is beneficial. Other odd jobs, such as paring the hoofs of the cattle, especially of the bulls, periodically weighing the cattle, clipping and dressing fat bullocks for the spring and autumn sales, fill up the rest of this interval.

At 4 p.m. the third ration of the day is given. It is simply a repetition of the first, namely, a supply of turnips and a foddering of hay or straw. The byre is again cleaned out. In some districts the turnips are pulped and fed along with chopped straw and some condiment, while in others a sheaf of corn is given instead of the straw. At 8 p.m. the cows are littered down for the night and a little hay or straw supplied, while the young bulls and yearlings receive the other half of the concentrated foodstuffs.

It is also the cattleman's business to see that the cows are served in due season, and that they are properly mated, the time of serving being noted for future reference. He must also constantly be on the watch at the calving season, to take precautions that the cows are not in a fat or plethoric condition as the calving period approaches, and to be on the guard against contagious diseases. The cattleman should be gentle with his herd. Harsh treatment is injurious, and is only conducive to viciousness among the cattle. The byre must also be whitewashed once or twice during the year, and occasionally disinfected.

In the summer time, when the cows or cattle are at the grass, the work is not so heavy, concentrated foodstuffs alone being supplied, but the cattleman must see that a regular supply of fresh water is maintained. [R. H. L.]

Cattle Plague, Murrain, Rinderpest.—Cattle plague has doubtless existed in south-eastern Europe for many centuries, but does not seem to have gained a footing in England until the year 1865, when it was introduced from Revel in some Russian cattle. Rinderpest is an infective disease generally confined to ruminants, but, according to some authorities, communicable to swine. The specific organism has not been certainly identified, but the manner of infection is presumably through the atmosphere, by which the membranes are made the medium of conveyance to the blood, setting up a disease by which secondary changes are developed in the digestive apparatus. That a fixed as well as volatile infective material is present is proved by the aerial infection already mentioned, and by the presence of the virus in the secretions and excretions, tears, saliva, milk, urine, fæces, sweat, &c. Intermediate bearers, animate or inanimate, convey the infection, as wild animals, hay, straw, skin, wool, clothing, railway trucks, and ships. While the cattleman's dog or the ship may be the medium by which the fixed contagium is carried long distances, and retains its virulence, it is notable how short a space of dry and pure air will nullify it; as when a ditch has served to draw a line of demarcation between the sick and the sound. A period of incubation of something

like six to nine days is usual, but shorter terms have been noted. A shivering fit, such as indicates the incubation of any disease with a high temperature (see FEVER), is followed by accelerated breathing, scarlet membranes or petechial spots upon them, loss of cud and of milk in cows, thirst, constipation; dry fæces invested with slimy mucus, followed by diarrhœa; discharge from the eyes, nose, mouth, and vagina of cows; emaciation, and death in a varying period. Notice to the police is required. A cordon is drawn round the infected place, and slaughter of in-contacts carried out under direction of the Board of Agriculture. This country has been free of cattle plague for some years past. See also art. ANIMALS, DISEASES OF; DISEASES OF ANIMALS ACTS; RINDERPEST.

[H. L.]

Cattle Ranching.—The large areas of natural pasture in the western and middle-western States of North America began to fill up with cattle about the middle of the 19th century. The men with capital, who carried on the business on a large scale, imitated and improved upon the methods of the original cattle owners, the Spanish Americans and Mexicans, and adopted, along with the picturesque costume of the cowboy, the name of 'ranch' and 'ranchman'. But cattle ranching has now become a general term for stock raising on all great holdings of cattle on primeval pastures, and has its corresponding institutions in the great 'estancias' or 'camps' of Uruguay, Argentina, and Patagonia, in South America, and in the cattle 'stations' of Australia and New Zealand.

North American cattle ranching spread from the warmer south-western States in which the Spanish element originally predominated, through Texas, New Mexico, Colorado, Wyoming, and Montana to the Canadian boundary. Wherever water and scanty herbage could be found on the borders of the Great American Desert the ranchmen pushed their herds, and for many a day, until indeed about 1887, this primitive, wasteful system of stock raising was profitable and popular. The original cattle were of Mexican type, long-horned, long-legged, razor-backed, and lean, the very antithesis of a modern feeding bullock. Upon this foundation the ranchmen gradually built up superior cattle by the use of bulls of improved breeds.

The Shorthorn was first utilized, and, as was to be expected, made a great improvement; but his stock were not too well adapted to the rigorous winters of the northern States, and he was superseded by the Hereford, which for long was the favourite improver of ranch cattle. The ranching industry reached the zenith of its prosperity between 1880 and 1890. About that period several hard winters, combined with overstocking, ruined many of the ranchmen, and, along with other causes which will be mentioned, gave it a set-back from which it has never recovered. Up to that time ranching was the roughest conceivable method of raising cattle. The land was unfenced and unimproved, and as it was common grazing, except perhaps a few score acres surrounding the ranch house and buildings, the cattle of any owner were practically indistinguishable, but for their brand, from those of any other owner. All ranged together over indefinite boundaries, comprising hundreds of square miles. Twice a year, as a rule, at the spring and autumn 'round-up', the cattle were gathered, the calves branded, and the stores or fat cattle selected for sale and shipment, or for the long overland drive to Chicago or St. Louis, a journey often extending over several months. As a rule, no provision was made upon the ranches for winter feeding or for watering in drought, so that in snowy winters and dry summers the cattle of the northern States perished in thousands. Gradually the great ranges contracted, population increased, settlers took up government land along the watercourses, shutting off the access from the waterless uplands. Barbed wire came into use, and as the ranches became smaller many were fenced; but fencing implied the purchase or rental of the land, more capital, and of necessity more careful methods. At present the great unfenced cattle-raising areas are few, and chiefly found in Montana and the Dakotas; apparently even they may in time give way, first to the small rancher, then to irrigation and the plough. The ranching industry in America to-day is still a great one, measured by the number of cattle raised and fed by the western States, but the great bulk of the stock are now bred on small ranches, the larger areas being devoted to grazing two, three, or four-year-old steers. The smaller ranches are fenced, hay is grown for winter feed, and in many cases meadows have been irrigated to supply forage of various kinds, including alfalfa. Some ranchers, instead of selling their stock as stores or range-fed bullocks, have erected immense feeding sheds and grown corn (maize), or imported it from the east to finish the cattle at home. The total number of cattle raised on American ranches will increase, in spite of the contraction of the ranges and the substitution of sheep for cattle. The small man will raise and feed many more head of stock, in proportion to the area occupied, than the large rancher who relied upon the public land unfenced and unimproved, and as the small ranchers become more numerous the large ranchers necessarily become fewer. The average price of range steers in Chicago, which is the chief market of the country, was about $4.40 per 100 lb. live weight in 1906.

Cattle ranching in the Canadian provinces of Saskatchewan, Alberta, and British Columbia dates from about 1873, when the mounted police brought a couple of cows and a few yoke of oxen to Southern Alberta. A Montana trading company also brought in a small herd to provide beef for the police, but it was a member of the mounted police who began the industry in 1876 by turning loose on the prairie a bull and fourteen cows which he had no other means of providing for. They survived the winter, wolves, Indians, and prairie fires, and proved that ranching was possible. In a few years several large ranches were started in the neighbourhood of Fort M'Leod, and from this point

ranching spread east, north, and west in Canada. The Canadian ranching area is limited to the district within the influence of the 'Chinook wind', a warm wind from the Pacific, which melts the snow and prevents the prairie from remaining long under severe frost. The grass is so nutritious, and the climate in the chinook area is so favourable, however, that the public ranges were soon filled up, and much of the land had to be purchased or leased, thus preventing the extension of ranching on the early American plan. Although stock will live and thrive during the winter with no extraneous feeding, most of the Canadian ranchmen put up large quantities of hay, and since irrigation schemes have materialized, other forage crops are grown for the stock. The ranching in Northern Alberta and Saskatchewan is on similar lines to that nearer the boundary line, but as the chinook is less frequent and less effective farther north, more shelter and winter feeding are required. Many of the British Columbian valleys have been found admirably fitted for cattle raising on a large scale, and considerable herds are found in the Kootenay, Nicola, and Okanagan valleys. Most of the Canadian prairie cattle are shipped eastward, from 60,000 to 80,000 head coming from the Alberta ranches alone. The recent prices at Winnipeg have ranged from $4 to $5 per 100 lb. live weight. The cattle were originally brought from Montana, and were therefore Shorthorn and Hereford grades of indifferent merit; but soon after the industry was seen to be a sound one, eastern cattle of good breeding were imported, especially bulls of good blood, so that the average quality of western cattle is now high. Aberdeen-Angus and Highland bulls have been tried, but the favourites are Shorthorn and Hereford. The number of horned cattle in the North-Western Provinces of Canada in 1906, just thirty years after the industry began, was over one and a half million.

The cattle stations of Australia resemble in their essential features the ranches of America. Against the advantage of a mild winter, or none at all, must be set the liability to prolonged and severe droughts, and the long carriage to meat-consuming countries. The Australian stations are as large as many of the American ranches; the cattle are numbered by thousands, graze over public as well as over appropriated land, and require many acres per head for subsistence. The main differences between the two systems are: first, the necessity for providing water from dams or artesian wells in the drier parts of the country, and the invariable use of stockyards for branding and gathering the stock. In America, water is seldom provided artificially, and the rope is still much in use for branding.

Cattle Raising in South America.—The importation of frozen beef from the Argentine has enormously increased in recent years, owing to the superb climate and cheap grazing lands of that country and the contiguous republic of Uruguay. The best lands for cattle raising in those countries are comparatively limited, and drought is always to be feared; but the cultivation of alfalfa or lucerne, which can resist drought and produce many crops in a year, has added greatly to the stock-carrying capacity of the 'camps' or 'estancias'. In the use of alfalfa for pasture and hay on a great scale the system of the 'estanciero' or ranchman differs from that of North America, but the general lines of work are the same, and the methods of improving the native cattle or 'crillos' by the use of imported bulls are similar. In South America, however, the favourite bull for purposes of improvement is the Shorthorn, while the Hereford, Devon, and Aberdeen-Angus are preferred in the colder regions. [R. B. G.]

Cattle Sheds.—These rank amongst the less permanent buildings for the farm, being structures less solid than we look for in barn, granary, and stable, and in the cattle houses proper (the byres and loose boxes). It would be truer perhaps to say that the cattle shed is simpler instead of less permanent than the other buildings which constitute the farm homestead. The cattle shed and open court generally go together. Cattle are only accommodated in this way at farms where straw is superabundant. Where the supply of the latter has to be economized, this is too wasteful a method so far as litter goes. The object aimed at in the court and shed is to get the surplusage of straw tramped under foot by cattle at liberty to move about in the two. The courtyard is usually enclosed by walls, some part thereof being utilized as the outer wall of the shed. Wood is sometimes used in place of stone or brick. In the former case there cannot, of course, be any claim to permanency. Wood in touch with rotting straw has a short existence. But stone or brick well put together will stand here as long as at any other part of the homestead. There is not much room, therefore, to cut down expense in the construction of the walls either of the enclosure or of the shed. One can save a little, however, as regards the roof. It need not be finished off so particularly as with the buildings quoted above. A leak here and there in the roof of the shed cannot matter very much. The shed is there merely for the purpose of toning down the asperities of rough weather. It is not advanced as a building the doors and windows of which can be made to render it independent of wind and rain. Corrugated iron comes in as a suitable enough material for the shed roof. Wood and felt answer if tar be applied thereto regularly. But the operation referred to is so apt to be overlooked at the farm that roofing of this description is not recommendable there. The open-board or space-board roof is quite suitable. As made plain in the article under head of Roofs, the bearers and boards that constitute a roof of this sort are kept clear of one another in such a way that water cannot lodge between them and lead to premature decay. No sooner does rain cease than the woodwork frees itself of water, and air being free to circulate round every part, the wood is kept in good order. A little moisture finds its way through the spaces between the boards when it rains. But this is not much of a fault in the kind of erection we are dealing

with. Eave gutters are out of place on the cattle shed. There is as often too little as too much moisture for the proper breaking down of the straw into manure under the feet of the cattle to seek to divert any of the rainfall over the area occupied by the shed and courtyard therefrom.

The matter of the size of the shed or the accommodation it should afford is ruled by circumstances, but perhaps half a dozen may be taken as the maximum number of animals that may with advantage be confined together. The class of cattle kept at the place, whether full-grown animals under process of fattening or store stock, will govern the amount of room required to accommodate the number quoted. It is hardly likely, of course, that a shed of this kind will stand alone. Whatever sheds of the kind there are about the place, good management speaks to their being placed together. If there be many, it is sometimes worth while arranging them in such a way that the group may have both a hay and cake-and-meal store and a turnip shed to itself, and thus help to save much of the time taken up in transporting small quantities. The straw is, of course, carted into the yard in large quantities at a time. Fig. 1 gives the ground plan of a single row of sheds and courts, with a fodder and cake house at one corner and a turnip house at the other. Fig. 2 gives a section of the same. The feeding-troughs and hay or straw racks are shown alongside the outer wall of the shed, thus admitting of the wants of the cattle being attended to from the covered path that runs between the two storehouses. In fig. 3 is shown a double row, the passage between serving both sides. Fig. 4 gives a corresponding section—minus the courts, however. This arrangement shows a different style of roof from the other. It represents a covering of corrugated iron sheets on each shed, with a subsidiary arch between the two over the passage referred to. Iron sheeting in the form of a curve can be securely fitted to the wallplates of buildings of narrow space, without the intervention of ties or cross pieces such as fig. 2 shows. The last-quoted figure shows a ridge roof, which may either be of open boarding, wood and felt, wood and slate, or of iron sheets. This form necessitates, as we have said, cross ties to hold the fabric together. The roof might have been shown as in fig. 5 but for the sake of illustrating alternative methods.

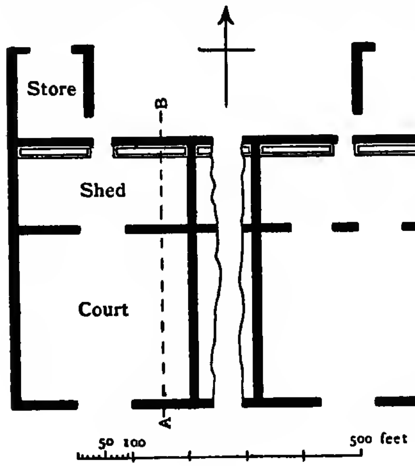


Fig. 1

Neither door nor window being needed for the shed, the fittings are simple in the extreme. A gate is required for the courtyard—one something after the type of an ordinary field gate, a little higher, perhaps, and it may be boarded in order to contribute to the seclusion of the inmates should this be considered advantageous. Wood troughs, capable of being raised and lowered in accordance with the depth of the litter in the shed, and simple hecks or racks are the only other fittings one needs to provide. In some cases, however, a supply of water in

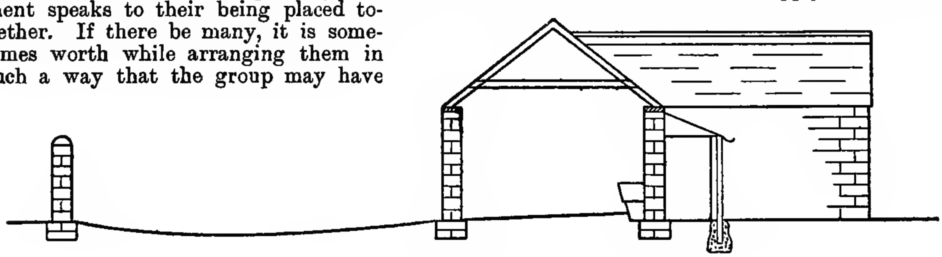


Fig. 2

the sheds is almost a necessity. When roots are plentiful there is no need for this. But as a rule this point is met without having to introduce water pipes into the sheds, which is a step to be avoided wherever possible. No artificial flooring is requisite. The subsoil is in nearly every case quite firm enough to receive the first layer of bedding and prevent the escape of moisture to any appreciable extent. In both sections we show a suitable conformation of floor both in yard and shed—in the former basined so as to prevent the gravitation of moisture therefrom, in the shed given a slope towards the yard, in order to prevent the bedding therein becoming too soft. The path along the outer wall of the shed is the better for a hard pavement, either of brick or concrete, so that the passage of barrows may be facilitated.

The side of the shed may be partly of wood—of stone or brick up to the level at which roots, &c., are passed through into the troughs. From here up to the wallplate it may be of wood, either close boarded or sparred according as the row is single or double. Where practicable it

is a good thing to have a door into each shed through this side. There should be a sort of hopper affair down which to slide the roots into the troughs. The latter are best in continuous stretches either the whole length of each shed, or in two where there happens to be a door and it is placed in the centre of the side wall. The long trough admits of the food being well spread out, thus enabling the cattle to feed apart to a greater extent than when their food is in a few heaps. The fodder rack may either be along this side wall or down the partitions between the separate parts of the shed. In the latter case, however, the presence of doors as

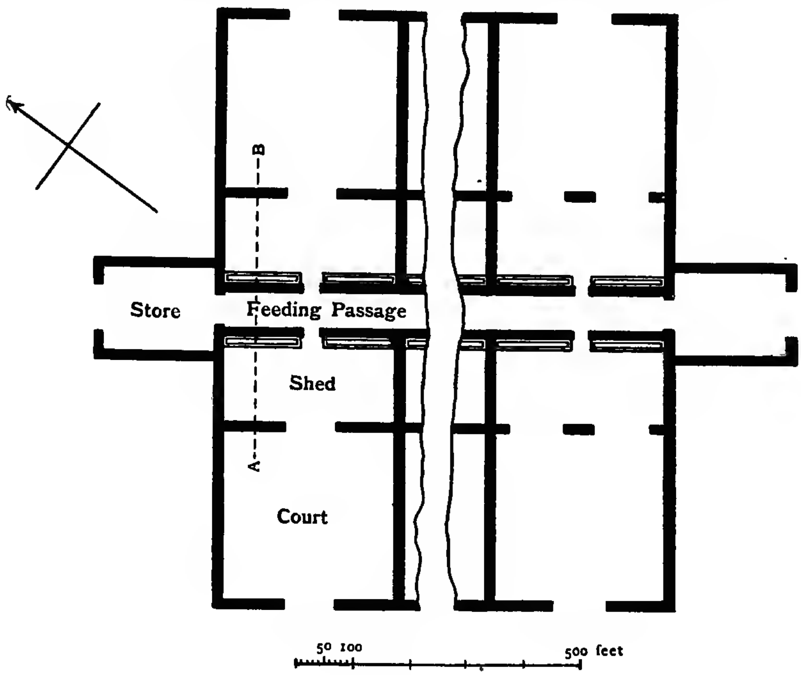


Fig. 3

referred to is an essential. In the former the rack can be filled direct from the passage. The partitions of the shed may be of wood, in which case they lend themselves convenient for the construction of fodder racks mutual to the two parts each one separates.

It need hardly be said that cattle sheds of this description ought to be given a favourable aspect. They should be so situated that the court is exposed to the maximum of sunshine and is sheltered from the coldest and most piercing winds. Lying open towards the south is the best exposure. And fairly high walls in the courtyards protect the cattle from wind.

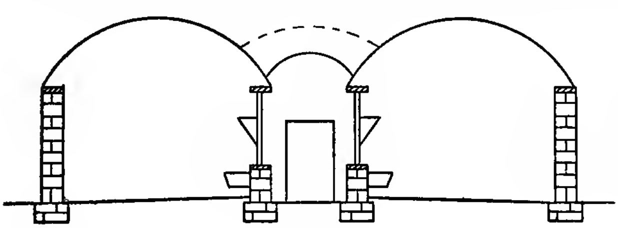


Fig. 4

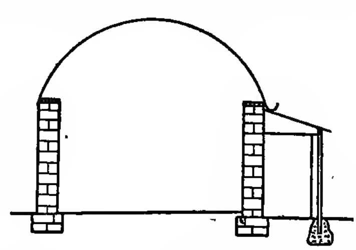


Fig. 5

On this account it is not advisable in windswept districts to have divisions of wood in the sheds. Neither is it advisable in these districts to have the side of the shed next to the courtyard too open. There, a single opening in the centre, say 7 or 8 ft. in width (wide enough, at any rate, for a cart to be backed in), might do. Elsewhere there may be two; or the side of the shed may be open altogether with the exception of the necessary supports of the roof. These, however, are points of detail that fall to be settled in accordance with the circumstances that apply in each case. [R. H.]

Cattle Straying.—'Horses, sheep, hogs, beasts, or swans' which have strayed on to a lordship may, after being proclaimed at church

and market, and exposed in an open place for a year and a day, become the property of the king, or of the lord of the manor to whom such prerogative has been granted by the Crown. In Scotland it appears that at one time a right of property in stray animals might similarly be acquired by anyone taking possession of them, but this right seems to be in desuetude. But anyone taking a stray animal may retain it until he is compensated for the finding, keeping, and proclaiming thereof. Stray animals found damage feasant (*i.e.* doing damage) may be distrained and held until satisfaction be made for the damage, cost of keep, &c. In Scotland, by the Winter Herding Act (which see), trespassing animals may be poinded and retained till the statutory penalties, cost of keeping, and compensation for damage done is paid. But where animals are lawfully in possession of a highway —*i.e.* are being driven along it under charge of someone—and stray therefrom on to adjoining ground, the owner or occupier thereof has no claim for damage done, unless he can prove negligence on the part of the owner or party in charge of the animals. In Scotland, animals found pasturing or straying on a turnpike road, whose owner cannot be found, may be seized by the road trustees and sold by order of the Court; the surplus of the price, after deduction of the penalty, costs, &c., if any, to be paid to the owner. Under the Burgh Police (Scotland) Act, 1892, cattle found at large in any street of a burgh may be impounded and sold for the penalty and expenses. Seven days' notice is to be given to the owner, if known, otherwise by advertisement, and the surplus of the price, if any, if not claimed within six months, is to be applied to the purposes of the Act. [D. B.]

Cattle-weigher. — Cattle-weighers or weighbridges are more frequently used than was the case until comparatively recent years, owing to the increase in the practice of selling cattle and sheep by live weight. The ordinary cart weighbridge, supplied with protecting fencing to keep the animals on the platform, is suitable for the purpose on the farm, especially as it affords the opportunity to weigh in and out other materials or produce bought or sold—a matter neglected more often than is desirable. Weighers to weigh single beasts are suitable for the farm; but larger machines, provided with an indicating dial and a weight recorder, are more convenient for markets, as a considerable drove may be weighed at once, and the weights are revealed directly to would-be purchasers around an auction ring; or the stamped ticket is a guarantee of weight where the farmer is his own salesman. It is now compulsory, by Act of Parliament, to erect cattle-weighing machines at all places where tolls are exacted on the sale of live stock, so that the seller and purchaser may form a more exact estimate of the weight, and therefore value, of the animals, and to give the less experienced a better chance of obtaining money value where otherwise they probably would not. A considerable amount of prejudice has existed, and still exists, as to making use of the weigher to record the live weight, but it is gradually disappearing, though far slower in the south of England than in the north and in Scotland. Tables showing the relative live weight to dead weight, based on actual results, are obtainable, and such as those compiled by Sir John Lawes, M'Jannet, and Joly are reasonably reliable, but some experience is required to apply them. The weighers are of the ordinary platform type, floating on knife edges, and when thrown out of gear the platform rests on flanges round the frame. [W. J. M.]

Cauliflower (*Brassica oleracea botrytis*).—This is a variety of the cabbage in which the flowers develop early, and as it were replace the heart-leaves, the flower-stalks being short and thick, and the flowers changed into mere points, the whole forming a dense, compact, succulent head. It appears to have been cultivated for ages in the island of Cyprus and on the coast of the Mediterranean, but nothing is known as to its origin. The Cauliflower is the tenderest of all the cabbage tribe. Even the Broccoli, which is nothing more than a coarse and hardier form of the Cauliflower, is injured by cold which would not hurt the ordinary cabbage.

The Cauliflower prefers a deep, well-manured soil, and of course a position where it will receive the full benefit of sunshine and warmth. The seeds are sown in August, the first week in the north, the fourth in the south, in drills 4 in. apart, in an open situation, preferably a sunny border. When the seedlings are large enough to handle they are pricked out 6 in. apart in good soil in a shallow, cool frame. Here they remain until spring, being exposed to all weathers except actual frost. If slugs trouble them, quicklime should be sprinkled over the soil. In March the plants should be transferred to the open, lifted with good balls of soil, and protected with handglasses, which should be removed when the weather is genial. In May they may be removed altogether. Market growers prick out the seedling cauliflowers in beds in the open, where they are protected from cold by means of hoops and mats. Seeds sown under glass in the middle of February, and the seedlings pricked out in a frame to be planted outside in May, will furnish a crop of heads in summer. They should be planted about 2 ft. apart. Or seeds may be sown in April, and the seedlings transplanted in June to yield heads in late autumn. Some of the best sorts are Large Erfurt, Autumn Giant, Walcheren, and Favourite. [W. W.]

Caustic Alkali Washes.—These washes are used to clean fruit trees and bushes from moss and lichens, and remove rough bark, &c., where various insects, such as Woolly Aphis, Apple-blossom Weevil, Codling Maggot, &c., hibernate. They produce a clean and healthy appearance in old trees. At one time they were thought to have an effect upon insect eggs, but such as those of Aphis, Winter Moth, Apple Sucker, and Lackey Moth are not in the least harmed. They have, however, a decided beneficial effect on Mussel and Oyster-shell Scales. One preparation is as follows:—

Caustic soda (70 per cent)	1 lb.
Carbonate of potash (80 per cent) ...	1 „
Soft soap (8 per cent potash)	½ „
Water to make up	10 gal.

The method of mixing is to dissolve the potash and soda in water, and then the soft soap in warm water; mix the three together, and then add enough water to make up to 10 gal.

Some authorities prefer using only caustic soda. When this is done the following is the formula:—

Caustic soda (98 per cent)... ...	2 to 2½ lb.
Water	10 gal.

Caustic potash is said to be equally effective alone when equivalent chemical quantities are used, that is, 3 parts of potash instead of 2 of soda. Caustic wash is still further improved by adding paraffin and soft soft. This is known as the Woburn wash, and is made as follows:—

Soft soap	½ lb.
Paraffin (solar distillate)	5 pt.
Caustic soda...	2 to 2½ lb.
Water...	9½ gal.

The soap and oil are made into an emulsion, and the soda is added.

It can only be used as a winter spray on dormant wood. As much as double the strength may be employed without injury to apple, pear, and plum. Its caustic qualities make it necessary to wear rubber gloves when spraying, or else the hands get burnt. [F. V. T.]

Cautery.—The application of the hot iron for searing, or for the division of tissues, is spoken of as the *actual cautery*. The employment of caustic substances, as powerful acids or alkalis, for the destruction of morbid growths is known as *potential cautery*. Much use is made of both in the practice of veterinary surgery. [H. L.]

Cayuga Duck.—In America wild black ducks are common, from which have been obtained on the one hand the small Black East Indian Duck, and on the other the Buenos Ayrean. The evidence obtainable would show that black ducks are chiefly found in South America, and that the Cayuga, which appears to have originated near the lake of that name in New York State, was due to crossing the wild black with ordinary domesticated ducks. In Britain this breed has never become popular, and is chiefly kept for exhibition purposes, in spite of the fact that it has excellent table qualities. Its unpopularity is due in some measure to its small size, owing to the crossing which has taken place with the Black East Indian to secure brilliant sheen of plumage, in which respect the last-named breed excels. Moreover it has dark legs, and on our markets this is a decided disadvantage. In America, the size of Cayugas is distinctly larger, as the crossing referred to has not taken place; but even there the breed cannot compare with other races for rapid growth and flesh properties, so that on the great duck farms of the Eastern States other breeds are kept (see Duck Breeding and Rearing, and Pekin Ducks). American Cayugas do not exceed 8 lb. when fully matured, and British are nearly 2 lb. lighter.

So far as shape of body is concerned the Cayuga closely follows the Aylesbury and the Rouen, that is, the line of keel is very level with the ground, but as the legs are somewhat longer it is carried well up. In correlation with the size the frame is long, broad, and deep, and the breast bone is thickly covered with meat, which is of fine texture and white in colour. In some of the English specimens the flesh is darker, betokening the crossing already referred to. The neck is long and the head fine, and the wings large and carried close to the body. The plumage is of a metallic black, the wings showing greater brilliancy than the body feathers. As stated above, breeders in this country have sacrificed size in order to secure brightness of plumage, which is a mistake. The ducks are fair layers. See Ducks, Breeds of. [E. B.]

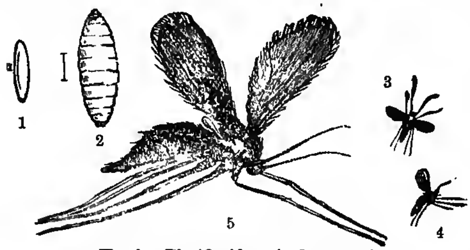
Ceanothus, a North American genus of Rhamnaceæ comprising forty species of shrubs hardy or half hardy in this country. Their blue, white, or pinkish flowers are attractive, and the advent of a number of very fine hardy hybrids, obtained from *C. americanus* and *C. azureus*, certainly places Ceanothus among the most desirable of the summer-flowering shrubs. The species most usually cultivated in gardens are: *C. americanus*, New Jersey Tea, 3 ft., white flowers; *C. azureus*, naturally making a straggling bush 10 ft. high, blue flowers; *C. divaricatus*, a blue-flowered evergreen species growing 10 ft. or more high, and a good wall plant; *C. rigidus*, an evergreen or sub-evergreen, small-leaved, small-growing, and of stiff habit, flowers deep-blue, and produced earlier than those of the preceding kinds; and *C. veitchianus*, an evergreen, making a large bush. The blue flowers are very abundantly produced, and this species is a general favourite, but it should have the protection of a wall. A selection of the hybrids should include Gloire des Plantières, Gloire de Versailles, and Indigo, blue; Cérès and George Simon, rose; and Albert Pettit, rose lilac. These are small-growing, and are well adapted for cultivation in beds. Ceanothuses are best suited by a rich loamy soil and a sunny position. They should be pruned after flowering, cutting back to two or three buds the shoots that are not required to extend the growth of the bush. Cuttings of half-ripened wood readily strike in heat. [W. W.]

Cecidomyia brassicæ (the Cabbage Cecid or Crucifer Midge).—The larvæ of this small midge live in the unripe pods of rape, cabbage, &c.; as many as sixty may occur in one pod. The pods swell and burst, become yellow, and are ruined; much loss of seed is thus occasioned. They are white and footless, with a yellowish median line, and with an indistinct brown anchor process; length, $\frac{1}{12}$ in. They are found in May and June. When mature, the larvæ fall to the ground and pupate; in ten days the midges swarm out and again lay eggs in the pods. The midge is $\frac{1}{12}$ in. long; head and thorax black, with grey hairs; abdomen pink, with brown or black bands; legs black, silvery beneath; wings transparent, flesh-coloured at base. They winter in the puparium stage in the soil, and some are harvested with the seed.

No treatment is possible, but some good may be done in prevention by deeply trenching land

where they have occurred, and being careful to obtain clean seed. [F. V. T.]

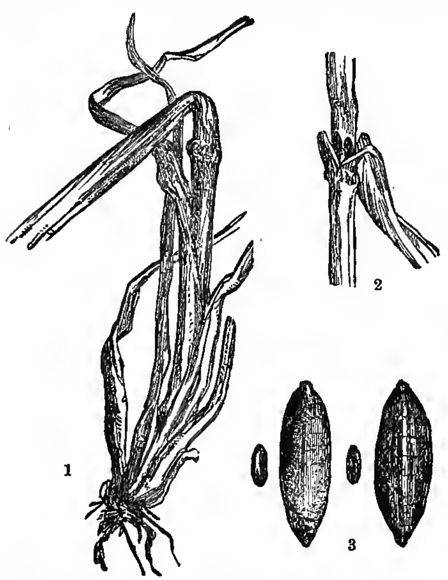
Cecidomyia destructor (the Hessian Fly).—This well-known midge is common to Europe and North America. It is far more destructive in the latter continent than in



Hessian Fly (*Cecidomyia destructor*)

1, 2, Egg and maggot, nat. size and magnified. 3, 4, 5, Flies, nat. size and magnified. (Ormerod.)

Europe, but nevertheless does much harm now and again in Britain. It is a native of Europe, and was imported into America by the Hessian troops at Long Island, and has since spread all over the American continent. It attacks wheat, barley, rye, and many wild grasses, but not oats. The adult fly is a small hairy midge, brownish in colour, with pinkish markings on the abdomen



1, Barley Stem attacked by Hessian Fly, showing straw bent down. 2, 'Flax-seeds' in position. 3, 'Flax-seeds' or puparia in different stages of development, nat. size and magnified. (Ormerod.)

in the female, much darker in the male. The female lays her small reddish-white cylindrical eggs in rows on the leaves of young wheat plants in May; the small white maggots crawl down the leafage and bury themselves in the leaf-sheath, generally taking up their position above the second node from the ground. Here they feed upon the sap of the plant and turn to the curious brown 'flax-seed' stage, in which the larva changes to the pupa. The 'flax-seed' stage is a true puparium, formed of the larval skin. The name is given on account of its resemblance to a flax seed. These bodies are found in the straw, in the stubble, and in light grain, chaff, and refuse. They may hatch out in September and give rise to a second brood, which lay their ova either on couch or timothy grass, and the maggots feed there all the winter and give rise to the May brood of flies which attack the corn. Many, however (probably the majority), remain in the 'flax-seed' stage all the winter. Their presence in the field is very marked, a crop attacked by the Hessian Fly has the appearance of having been weather-beaten, the straw bending over just above the larvæ or flax seeds, that is, usually above the second node; consequently much is damaged and shrivelled or entirely ruined. In America the second brood lays its eggs on the young autumn-sown corn, and the maggots feed in the crown of the plants just about ground level and kill them completely. This may happen in rye with us, but the majority live over the winter on the ground, or in machine refuse and in wild grasses. The Hessian Fly eggs and maggots are subject to the attack of numerous parasitic Hymenoptera (Chalcididæ), and it is largely owing to these that it causes but little harm with us.

In those areas where it is found, it is well to use only the stout-strawed varieties of corn. After an attack the crop should be cut high, and the stubble or 'gratten' burnt. All infested screenings should be burnt, and light grain fed to stock. [F. V. T.]

Cedar (Cedrus) is an introduced evergreen genus of the Abietineæ tribe of the Coniferæ family of gymnosperms. It has long shoots with scattered leaves and dwarf shoots with tufted leaves, which are linear and persistent for three to five years, and darker and stiffer than those of the Larch, its closest relative botanically. The stem bark is rough and much fissured, and the boughs are not definitely arranged in false whorls. In old age the trees are apt to have a flat-topped tabulated crown when growing isolated, and particularly so in exposed situations. Both the male and female flowers occur on the same individual in early autumn, the catkins being solitary and terminal on the dwarf-shoot spurs, where they form long, oval, erect cones attaining from 2 to 5 in. in length and $1\frac{1}{2}$ to 3 in. in thickness. The thin cone-scales, which are longer than the bracts and closely set, fall off (as in the Silver Fir) when liberating the triangularly broad-winged seeds, and leave the spindle bare and erect. The seeds are about half an inch long, and take two years to ripen (except in the Deodar, which ripens in thirteen months). The seedlings have from eight to ten narrow cotyledons. Highly prized where indigenous, the trees are of no importance for timber - growing in Britain. The heartwood varies from yellowish-brown to reddish-brown, and is fragrant of an essential oil, but there are no resin ducts in healthy trees.

Three species, all highly ornamental trees, are recognized and have been introduced into Britain, where they are quite hardy; but they are by

some held to be more probably climatic and local varieties than truly different species. These are the Cedar of Lebanon (*C. Libani*), the Deodar or Himalayan Cedar (*C. Deodara*), and the Atlantic, Algerian, or Mount Atlas Cedar (*C. Atlantica*).

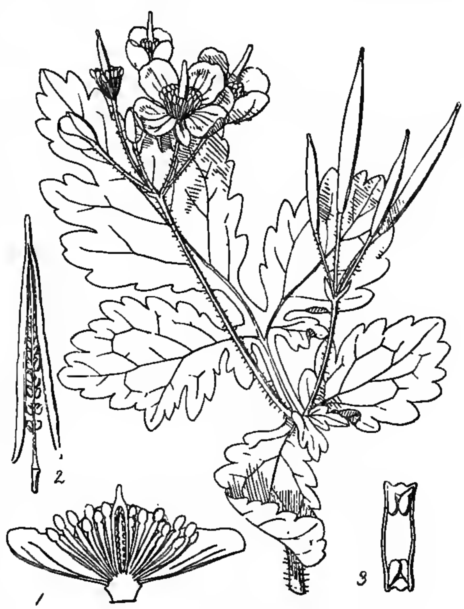
1. The *Cedar of Lebanon*, the parent type, is indigenous to Mount Lebanon, the Taurus and Anti-Taurus Mountains of Asia Minor at an elevation of 4000 to 6400 ft., and to Cyprus. The first specimens in Scotland were planted in the Edinburgh Physic Garden in 1683. Its characteristic form of growth is to throw out long, strong side-branches which soon divide the bole, unless the stem be drawn up by surrounding trees. But as its only value in Britain (like that of the other two kinds) is for ornament, in an isolated position it generally forms a somewhat bent and irregular stem and broadens out into a wide-spreading lawn tree with a rounded contour and often an almost flat top. The foliage is shorter, but denser and darker-hued than in the other two species, and casts a deeper shade. The tree can attain a great age. In 1860 Hooker found that the ancient forests of Lebanon, so often referred to in the Old Testament, consisted only of about 400 trees, growing in nine groups, varying from about 100 to perhaps 2500 years of age. The largest specimens in Britain are probably, as regards height, one of 109 ft. by 12 ft. 2 in. in Bucks (estate not named) reported to the Board of Agriculture in 1903, and, as regards girth, one measuring 19 ft. 9 in. in 1900, which is growing on the lawn at Little Durnford (Salisbury). The most interesting group of Lebanon Cedars is the avenue of 170 on the Dropmore estate (Bucks), planted over ninety years ago, and now over 70 ft. high and 8 ft. in girth. Planted at a distance of 25 ft. in two lines 50 ft. apart, their crowns now completely overshadow the roadway.

2. The *Deodar* or *Himalayan Cedar* is indigenous to Afghanistan and the western Himalayas, where it occurs at from 4000 to 12,000 ft. elevation, attains a height of up to 250 ft. under favourable circumstances, and produces a yellowish-brown, strongly scented, and very durable timber. It was introduced into Britain in 1822. It is easily distinguishable from the Cedar of Lebanon by its drooping branches and its lighter-green, less ornamental appearance generally. While young its shape is more pyramidal, although the top shoot is almost always bent sidewards; but in old age it also becomes round in the top. In 1903 the tallest specimen reported in Britain was 102 ft. high by 8 ft. 5 in. in girth (Bucks, sixty-three years old), and the thickest was 73 ft. high with a girth of 10 ft. 9 in. (Kent, sixty-two years). At Kew it is the first of the three Cedars to flush its new leaves in spring, about a fortnight before the Cedar of Lebanon, which precedes the Atlas Cedar by a few days.

3. The *Atlantic* or *Atlas Cedar* is indigenous to the Atlas range and the other mountains in Barbary at 7000 to 9000 ft. elevation, and was introduced into Britain in 1843. It has short needles like the Deodar, but the tint of its foliage is usually darker, although it is easily distinguishable from the Cedar of Lebanon by its more rapid growth, its more upright habit, and its fewer branches, which are not pendulous like those of the Deodar. In Britain the stiff extremities of the boughs generally incline sharply upwards, and the main leading-shoot remains erect.

All these three species produce germinable seed during warm years in England. Seeds sown in April with a covering of about half an inch of mould come up in five or six weeks. When one year old seedlings can either be potted or transplanted till large enough to set out, when of course they do best in sheltered situations. The Atlas is the only kind which does not stand transplanting well. They all do best on a well-drained, deep, and permeable soil, though the Deodar in particular thrives well on a rather limy ground. There are various garden varieties (columnar, weeping, &c.), though the ordinary kinds are by far the most ornamental. [J. N.]

Celandine, or **Greater Celandine** (*Chelidonium majus*), is an excessively poisonous



Greater Celandine (*Chelidonium majus*)

1, Section of flower; 2, Fruit; 3, Cross section of fruit.

member of the Poppy order (Papaveraceæ), frequently found growing on rubbish or in hedges near villages and old ruins. The plant is a perennial with fœtid odour, erect and branched, 1 to 2 ft. high, and full of yellow juice. The leaf has a waxy skin, and is pinnately divided into broad rounded lobes. The flowers are small and yellow, three to six together, forming a loose umbel at the end of a long stalk. The fruit is a pod, $1\frac{1}{2}$ or 2 in. long, nearly cylindrical, and when ripe opens by two valves like the siliqua fruit of a turnip. The yellow juice, the one-chambered ovary composed of two carpels, and the two-valved fruit suffice to distinguish

it from the other plants of the Poppy family. The poisonous principle is contained in the yellow juice, and although the plant is dried, none of the poison escapes. Animals do not readily eat Celandine, but horses have sometimes been poisoned through partaking accidentally of this plant.

A perennial plant of the Buttercup family (Ranunculaceæ) is also called Celandine, or Lesser Celandine (*Ranunculus Ficaria*). This Celandine has three sepals and nine yellow petals. The leaves are very glossy and are kidney-shaped, with rounded teeth on the margin. The plant is often seen in bloom in the month of April among grass under trees, and is a favourite from being one of the first wild plants to be seen in bloom in spring. The name 'celandine' is from Greek *chelīdōn*, a swallow, and both plants are also known as 'swallow-worts'. [A. N. M'A.]

Celeriac.—The Turnip-rooted or Knob Celery (see fig.) is a variety of the ordinary celery remarkable for the large size of the root, which is swollen and turnip-like, while the leaf-stalks are comparatively short. It is grown chiefly for flavouring, the roots being lifted and stored in the winter out of the reach of frost, when they will keep quite fresh for months. The plants are raised from seeds under the same treatment as for celery, and they are planted in the open border early in June. The swollen rootstock is best developed when the plants are

Celeriac—Turnip-rooted or Knob Celery

set shallow, that is, with the roots only just buried. A few weeks before lifting, the whole of the root should be covered with soil, which has the effect of blanching it. Properly treated, the roots grow to a weight of 3 or 4 lb. [W. W.]

Celery, a hardy European biennial (*Apium graveolens*) frequenting marshy places in this country, but the wild form is considered dangerous to eat. It is one of the most esteemed of vegetables, requiring a good or highly enriched soil, and special methods of cultivation to attain to perfect development. It is usual to sow seeds in heat early in the year, but good results are also obtainable from later sowings out-of-doors. In either case the seedlings must not be crowded;

Celery—Dwarf Solid White

it is best to transplant them when they have three leaves, and they must be kept steadily growing under equable conditions until they are finally planted out in May or later. Celery is usually grown in trenches. These should be taken out some time before they are required, so as to be available for planting during suitable showery weather, and they should be on land which was heavily manured for previous crops. Indeed celery is well suited by rotten manure alone, an abundance of water being also a highly important particular. It is usual to make the trenches 18 in. wide and 9 in. to 1 ft. deep for the earliest crop, introducing a layer of manure and lightly digging it in. Plant in a single row along the centre of the trench 6 in. to 1 ft. apart, according to the size of heads required, and water well in. Later batches are planted nearer to the surface. Subsequent cultivation consists in affording a liberal supply of water, removing side-shoots, and keeping clear of weeds. Earthing-up should not be commenced until the plants are nearly fully grown; it must always be carefully, and at first it should be only loosely, performed. Late-standing crops are protected from excessive rain and frosts by being tilted at the final earthing-up, by litter, by hurdles, &c., or they may be taken up and buried in light soil or in sand in shelter. Celery is also grown upon the bed system, but this is not suitable for early crops. The best varieties include Dwarf Solid White, Dixon's Mammoth White, London Market Red, and Standard Bearer (Red). The seeds are used for flavouring soups, &c., as is also a preparation known as celery salt. See also CELERIAC. [W. W.]

Celery.—Parasitic Fungi.—

LEAF SPOT.—Small warts which break and cover the foliage with brown spores indicate Rust (Puccinia). The disease known as Early

Blight is first seen on the outer leaves as rounded greyish-green or brown spots; during moist weather the leaves rapidly turn yellow and the whole crown is attacked, becoming coated with an ash-grey mould formed by the conidial branches of a fungus (*Cercospora apii*). Late Blight appears as irregular spots, and the leaf becomes brittle and withered; the distinguishing feature is the presence on the discoloured places of minute dark dots embedded in the leaf, these are the spore-cases of *Septoria petroselina* var. *apii*.

Treatment.—Results prove that healthy foliage can be obtained by spraying, and that the benefit will repay the expense if the crop is grown on a large scale. Bordeaux mixture (see FUNGICIDES) is sprayed on the seedlings twice before transplanting; no further treatment may be needed, but if leaf-spotting is observed, the spraying should be resumed and repeated every three weeks. Diseased tops should be burned, especially where celery is grown year after year on the same land.

HEART ROT.—The earthing-up of celery in trenches is very favourable to the growth of certain fungi and bacteria which produce soft rot. On the first signs of this heart rot, the simplest plan is to use the healthy plants as soon as possible and to burn the rest. The use of boards instead of earth, or growing the celery in closely planted beds, has been recommended, because it allows of more ventilation. Heart rot and late blight may also cause much damage amongst stored celery unless it is suitably ventilated. [W. G. S.]

Celery Fly. See ACIDIA HERACLEI.

Cellulose was originally only the botanical term applied to the matter composing the framework of the woody substance forming the walls of the woody fibres, vessels, and cells in ligneous plants, which undergoes transformation by the process of lignification. The chemical formula for cellulose in its pure state is $C_6H_{10}O_5$, and it is white and silky, translucent, hygroscopic, and without taste or smell; but it is never found pure in any plant, owing to all lignified tissues containing lignin and other substances. Its purest natural form is in raw cotton and the pith of various plants. But it forms from 47 to 62 per cent of the dry woody substance of our forest trees, the remaining 38 to 53 per cent being lignin, which is hard, stiff, and less hygroscopic for fluids than the elastic and permeable cellulose. The secondary and mercantile meaning of the term 'cellulose' is the commercial product obtained by converting woody fibrous substance mechanically into wood pulp, and then also chemically extracting the cell substance of the pulp to form material for papermaking, &c. Paper is now largely made from this. Owing to the paucity of our woodlands there are only few cellulose factories in Britain, and these have to import their raw material from abroad. Saxony was the birthplace of this industry, the first wood-pulp mill being started in 1854, and the first cellulose factory in 1874; and since then these industries have developed to an enormous extent throughout Northern Europe, the United States, and Canada, the countries containing the largest supplies of the softer kinds of woods (coniferous and broad-leaved) not having hard and heavily lignified tissue in the shape of heartwood. Cellulose is made from wood that is first cut by rotating machinery into small thin-sliced chips, then ground down between grooved rollers, and boiled under high pressure along with chemicals to macerate and disintegrate it. Caustic soda and calcium sulphite are the chemicals used in what are known as the alkali and the acid processes, while an electro-chemical process is also recently in use, where currents are passed through a solution of sodium chloride or common salt to produce a strong caustic lye and a bleaching powder. The alkali (soda) process is the oldest, but as it is dearer than the acid process and yields a smaller amount of cellulose, though of finer quality, this latter method is now prevalent. In it the macerating principle, calcium bisulphite, is obtained by dissolving sulphate of lime in hydrated sulphurous acid, the sulphurous acid being the active agent in dissolving the encrusting ligneous substance without wasting much of the cellulose itself; and the cellulose thus got is easier to bleach, though less soft and pliable, than soda-processed cellulose. The raw cellulose thus obtained is broken up and strained in revolving drums, then dried and pressed under slowly rotating heated cast-iron cylinders, then bleached with chlorine to the extent required, all unnecessary bleaching being avoided as it diminishes the strength and elasticity of the felty fibres. The outturn in cellulose is about the same weight for weight of the raw material used, but softwoods like willow, poplar, spruce, silver fir, and such like are the easiest and cheapest to treat, and are therefore everywhere preferred, when available. One ton weight of dry wood gives about 6 cwt. or 30 per cent of cellulose by the soda process, and about 10 cwt. or 50 per cent by the acid process, and its value is from about £7 to £8 a ton. For commercial purposes cellulose is transformed by the use of concentrated acids. Treated with sulphuric acid, for example, it becomes 'vegetable parchment', and with nitric acid 'gun-cotton', 'collodium-wool', &c.; while from gun-cotton is produced the hard and highly inflammable 'celluloid' used for making billiard balls, combs, imitation ivory, &c.

Cellulose forms the principal constituent of the crude fibre of feedingstuffs. The cellulose in young plants is more readily digested than that in mature plants. In the latter case it becomes impregnated with lignin, cutin, &c., which protects the cellulose to some extent from the action of the juices in the alimentary canal of animals. Ruminants are the only class of animal capable of digesting cellulose to any extent. [J. N.]

Celosia, a genus of tropical and subtropical herbaceous plants, two of which are popular in gardens, namely the Cockscomb (*C. cristata*) and the Plume Plant (*C. pyramidalis*). Both are raised from seeds sown in March in a warm house, the seedlings being transferred to small pots and repotted again into 6-in. pots. They prefer a loamy, well-manured soil. The Cockscomb grows about 9 in. high, and its flowers are arranged

on a fleshy, compressed, undulated head, after the manner of a cauliflower, but with the appearance of the rose-comb of a fowl. They are coloured crimson, scarlet, or yellow. By growing the plants in a frame on a hot-bed and keeping them close to the glass they form heads nearly a foot across. *C. pyramidalis* is used both as a decorative plant for the conservatory and for summer bedding; it produces plumose spikes 2 ft. high of white, yellow, or crimson flowers. Both species are natives of India. [W. W.]

Cement.—The only article of this kind that is of any consequence in estate and farm affairs is Portland cement. Under the head of CONCRETE the importance of this substance in building operations at the farm is pointed out. A generation ago Portland cement was not much known in country work. Roman cement was occasionally used in this connection. It possesses most of the useful qualities of Portland cement, but in modified form. Both are allied to common building lime—lime mortar. They, however, possess the property of 'setting' firmly under water. The other has not this property. Under any conditions it takes long to become hard. But the two cements 'set' quickly whether clear of water or under it. There are kinds of lime, however, that have more or less of this property of hardening under water. These are known as hydraulic limes, and previous to the introduction of Portland cement, they were used in dock building. Their difference from ordinary limes in this respect is due to the presence of a certain proportion of clayey matter in the limestone out of which they are prepared. Ordinary lime is prepared from almost pure limestone—pure carbonate of lime. The cements referred to were first prepared from natural deposits containing the proportions of clayey and siliceous matters to carbonate of lime that go to constitute a substance capable of yielding cement—Roman cement from some of the volcanic deposits found in Italy, Portland cement from some deposits in the Portland beds of the Oolitic rocks; consequently their use was limited. Once, however, it became practicable to manufacture them artificially, the application to general purposes of the more generally useful cement spread rapidly. There must be an immense quantity of Portland cement manufactured nowadays. In all kinds of work on which water comes in any way to bear, Portland cement is of eminent value whether as regards sea or river. In harbours and docks, piers and breakwaters, river embankments and weirs or barrages, and for tanks it is the handiest of materials; and it is permanent to a great degree. It is usual when big jobs are in hand to stipulate that the cement to be used must stand a certain degree of pressure. Handy instruments are forthcoming for this purpose. One is apt to overlook this precaution in ordinary estate work, taking it for granted that so long as a good brand of cement is being made use of all is well. It is worth while, however, to put the matter to test occasionally. [R. H.]

Cemiostoma laburnella (Laburnum Blister Moth).—This small moth in its larval stage causes the round blisters on the laburnum leaves. The moth is only ¼ in. across the wings, which are white with yellow marks near apex of fore wings, and a dull purple-brown spot with dark radiating lines on the fringe; head and thorax white; abdomen grey. It appears in May and again in July and August in two broods. Eggs are laid on the under side of the leaves, and the larvæ bore into the leaves, forming first a small tunnel, then a round blister with crescentic rings of dark excrement. When mature the larvæ are ¼ in. long and pale-greenish; they spin a white cocoon attached to the leaves in summer; those of the second brood amongst debris under the trees and in bark crevices. All debris should be removed and burnt in winter, and the trees sprayed with caustic wash. Caustic wash for this purpose may be made by dissolving 2½ lb. of caustic soda (98 per cent) in 10 gal. of water. [F. V. T.]

Cemiostoma scitella (Pear and Apple Leaf Blister Moth).—The larvæ of this moth produce the round blister-like spots on the upper side of apple and pear leaves, often ½ in. across, and usually showing concentric dark rings of 'frass'. They are frequently so abundant on pear as to destroy all the foliage. The moth appears in April and May, and again in June and July; its wing expanse is ¼ in.; colour leaden-grey; the tip of the fore wings brown with two white marks separated by a coppery band, and beneath these a black spot with violet pupil, the fringe is dingy-white with four radiating black lines at the apex; hind wings leaden-grey, with pale-grey cilia. The eggs are laid beneath the leaves. The larva found in the blister is at first pale, then becomes green, with brown head, six brown true legs and pale sucker feet, on segments 3 to 6 are blunt lateral processes. When mature they are ¼ in. long; they then leave the blisters and spin a cocoon of white silk either amongst leaves on the ground or in the soil. They remain in this stage all the winter. Other food plants are Hawthorn and Mountain Ash.

Attacked trees should have all rubbish cleared from beneath them in winter and the soil deeply dug or removed. Arsenate of lead spray has been found effectual if used when the moths are first seen, so as to poison the larvæ as they eat into the leaves. It is best to use the arsenate in the form of a paste (Swift's paste). Small trees should have the blistered leaves hand-picked before the larvæ escape. [F. V. T.]

Centaurea.—This is a genus of composite plants which includes two well-known weeds, namely Hardhead or Knapweed (*Centaurea nigra*), a purple-flowered perennial in pastures, and Cornflower (*Centaurea Cyanus*), a blue-flowered annual or biennial in corn. In the Centaurea genus all the flowers are tubular, as in thistles, but the involucre leaves round the head are dry scales destitute of spines; the leaves also are destitute of spines. Various showy members of the genus are cultivated in gardens. [A. N. M'A.]

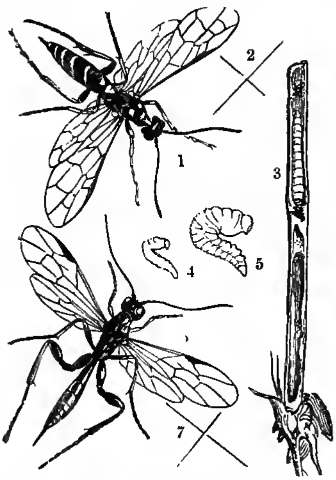
Centipedes. See MYRIAPODA.

Centranthus, a genus of ornamental herbaceous annuals and perennials, several of the species being valuable garden plants well

adapted for rockwork. Of these the most popular are *C. macrosiphon*, an annual from Spain with pretty rose-coloured flowers, and *C. ruber*, the Red Valerian, a perennial and a very old favourite which has become naturalized in chalky districts. Its white- and purple-flowered varieties should also be grown. [W. W.]

Cephalotaxus, a genus of small yew-like conifers, natives of China and Japan. The leaves are linear, two-rowed, sharply pointed; flowers diœcious and borne in clusters; fruits plum-like. The best-known species are *C. drupacea*, *C. Fortunei*, and *C. pedunculata* (bush-like in habit). The variety *fastigiata* of the last named is of upright habit, and somewhat resembles an Irish yew. They are quite hardy, and will succeed in any soil. Propagation is usually effected by cuttings, these being inserted under lights in August or September in sandy soil. [W. W.]

Cephus pygmæus (the Corn Sawfly) is often not uncommon in our cornfields, and



The Corn Sawfly (*Cephus pygmæus*)

1, Female fly; 2, natural size of female; 3, maggot in case; 4, maggot; 5, same magnified; 6, parasitic ichneumon (*Pachymerus calcitrator*); 7, natural size of ichneumon.

abounds on umbelliferous flowers, and the long grass which springs up on the surrounding banks in June and early in July. The females, which are most abundant, lay their eggs in the stems of wheat and rye, either below the first joint or just under the ear. The maggot hatches in about ten days; it is white and fleshy with a horny head, and unlike most sawfly larvæ has no legs. When mature it reaches about $\frac{1}{2}$ in. The young maggot consumes the inside of the straw, ascending and sometimes perforating all the knots before it is full grown, when it descends to the base of the straw and cuts it down nearly level with the ground at harvest time. It immediately encloses itself in a transparent cocoon within the stump of straw, a little below the surface, and closes its cell with excrement and bits of food. There it rests secure through the winter, and in March it changes to a pupa, and is transformed to a sawfly, occasionally as early as April, usually in June. The flies are shining black, with yellow on the neck and at the base of the abdomen, across which are two yellow rings and a spot, in the male; the tip is also yellow, as well as the mouth, hips, inside of thighs, shanks, and feet; inside of hinder shanks and feet brown. Female larger; two antennæ shorter and stouter; four wings smoky; face black; abdomen compressed, with a short black ovipositor at the apex; hips and thighs black, tips of the latter yellow.

Infested stalks may at once be known by the thin white ears, with but few perfect grains. Later, the attack is easily identified by the fallen straws, severed by the larvæ.

A parasitic ichneumon, called *Pachymerus calcitrator*, infests the larvæ of the Cephus.

Treatment consists in destroying the larvæ by scarifying the stubble, harrowing it together and burning. [J. C.] [F. V. T.]

Cerastium. The botanical genus to which the Chickweeds belong. See CHICKWEEDS.

Cerceris arenaria is a sand wasp, which captures the weevils that feed upon the pea and bean crops and fruit trees and bushes, &c., and buries them in the nests she forms so as to support her larvæ. Freshly emerged weevils are chosen, and these the larval Cerceris can easily make use of for food, sucking their body juices from between the segments. These beneficial insects are very fond of dry, sandy soils exposed to the noonday sun, and choose banks and pits to form their tubular nests. The insect is banded black and yellow, the segments of the abdomen being constricted. It reaches $\frac{3}{5}$ in. in length. [J. C.] [F. V. T.]

Cereals. — The term 'cereal' is applied to a number of species of grass which are grown mainly for their fruits or 'grains'. The chief representatives are wheat, barley, oats, and rye, cultivated in more temperate regions, and rice, maize, durra, and millet, adapted to warmer climates. The true fruit of the cereals is a caryopsis or nutlike structure, containing an embryo and a store of food for it—the endosperm—which consists largely of starch (57 to 70 per cent.) and proteids (7 to 13 per cent). In some species, as in wheat and rye, the commercial 'grains' are naked caryopses; in others, such as oats and barley, they are caryopses more or less closely invested by glumes or chaffy scales. Before germination of the grain takes place after sowing, it absorbs about half its weight of water. The best temperature for growth of the seedling is about 25° C. for wheat, rye, and oats, about 20° C. for barley, and 32° to 35° for maize and other cereals of warm climates. Below 2° or 3° C. the first-mentioned kinds do not germinate; maize needs a temperature of about 8° to 10° C. before it will grow. The roots of cereals are thin and fibrous, like those of ordinary grasses. The first, which emerge from the embryo within the seed, live a short time only, but are succeeded by others which arise from the lower nodes of the stems. The main stem bears buds only in the axils of those leaves which are just below the surface of the soil. From the buds branches arise, and these may

branch again more or less extensively. This peculiar habit of producing branches from parts of the stem situated just within the soil is known as 'tillering', and is common to all cereals and grasses. The number of 'tillers' which may originate in this way from the embryo of a single seed varies with the kind of cereal and also with the treatment it receives.

Wheat and barley 'tiller' more than oats; even varieties of the same species differ in this respect. Light, thin-sowing, deep cultivation and heavy manuring of the soil, as well as early sowing, promote 'tillering'. Generally not more than about five or six ear-bearing stems arise from a single grain, but the numbers may be a hundred or more under certain favourable conditions of soil and cultivation.

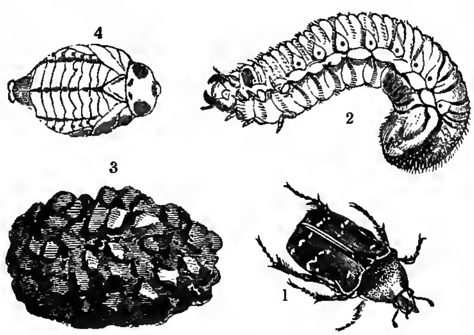
The elongation of the internodes of the stems and the pushing forward of the growing ear out of the enclosing leaf-sheath is known as 'shooting' of the crop. Soon after this occurs, grain crops often become 'lodged' or 'laid', especially if heavy rain or strong winds prevail. The straw or stems of laid plants have in the parts near the ground internodes and cell walls which are longer and thinner than usual. The special cause of these abnormal features, which result in basal weakness of stem, is absence of adequate light to the young plants, a condition encouraged by thick seeding, and use of large doses of nitrogenous manures.

The flowers of the common cereals—wheat, rye, barley, and oats—are enclosed between two chaffy glumes. When the flowering stage arrives, the glumes separate from each other and then close, the time occupied in the process being about three-quarters of an hour. During this short period the filaments lengthen, and the anthers open and shed their pollen, most of which is left in the flower, so that self-fertilization generally takes place. The flowers of wheat open mostly in the early morning. Although natural cross-fertilization is possible in cereals which open their flowers in this manner, few crosses have been met with in nature except in oats and rye. In some varieties of barley the flowers never open, so that crossing is impossible in these cases. Soon after the pollination of the flowers, fertilization follows; the ovum develops into the embryo, and the endosperm tissue begins to form. The latter becomes gradually filled with starch and proteid grains, as well as other substances needed for the future nutrition of the embryo when germination occurs. [J. P.]

Cesspool, a cistern or catch basin for collecting and retaining liquid manure.

Cestodes, or **Cestoidea** (Tapeworms).—These are worms belonging to the Flatworm series, and receive their name from the fact that the majority are, in the adult condition, of a flattened bandlike shape, and sometimes of very considerable length. They are internal parasites of animals, and have two definite stages in their life-history, each of which involves a separate host. The characteristic tapeworm stage occurs in the intestine of vertebrate animals. It is of a dead-white colour; at the anterior or head end there are organs of fixation, minute hooks or suckerlike slits, or sometimes both, by means of which these parasites maintain their hold upon the host. Behind this there is very generally a short part termed the neck, a region where growth in length of the tapeworm takes place. The rest of the worm consists of a series of segments, which may be very numerous, the oldest, *i.e.* the ripest, of which are farthest from the head. These segments are practically reproductive buds; each contains a set of complex hermaphrodite sexual organs producing very large numbers of eggs. Tapeworms have no alimentary canal; feeding is effected over the whole surface of the body by absorption of the juices amongst which they live. The asexual or cystic stage (see CYSTICERCUS, CŒNURUS, ECHINOCOCCUS), which arises from the development of the fertilized egg of the adult, occurs most commonly in the flesh or connective tissue of herbivorous animals. It reaches this situation through the egg having been swallowed amongst food. The young embryo developed therefrom bores through the wall of the alimentary canal and is carried in the bloodstream to the tissues, or else actively works its way thereto. The subsequent development into the tapeworm stage takes place only when the infected tissue, swallowed as food, arrives in the alimentary canal of the next host. Tapeworms are abundantly represented by numerous families amongst all classes of vertebrates, the most important of which are the Tæniadæ and Bothriocephalidæ infesting mammals and birds. See TÆNIA. [J. R.]

Cetonia aurita (Green Rosechafer) is a splendid beetle, which lives upon various flowers,



Green Rosechafer (*Cetonia aurita*)

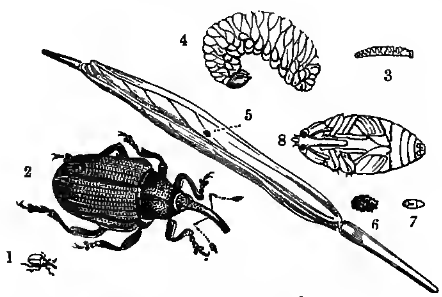
1, The beetle; 2, the larva; 3, pupal case; 4, pupa.

and sometimes is seen in multitudes flying about and settling upon the blossoms of turnips left for seed, the petals and anthers of which it consumes, and renders the pods abortive, it is also destructive to roses, beans, currants, apples, and the strawberry. It is generally distributed over the south midlands of England, but becomes rarer in the north.

C. aurita is polished and green, with a metallic golden tinge. It appears in May and on through June. The eggs are laid in the earth, where the larva lives, and does great mischief in nursery grounds by feeding upon the roots of roses, vines, &c. The larva is fleshy like that of

the Cockchafer, but may be told by having a deep reddish-brown spot on each side of the first segment, and the legs are also longer. It takes from two to three years for the larva to reach maturity, when it measures 1½ in. To undergo its transformations it constructs an oval earthen case in the ground, which is rough outside, and in this cell it changes to an ochreous pupa. Pupation takes place in summer. The pupa is of an ochre colour. The beetles may be collected by jarring, and the white grubs by placing pieces of rotting turf under the soil. The grubs also occur in heaps of leaf mould in cucumber beds and in decaying wood. Any seen in the two former when moved should be collected and destroyed, and all rotting wood and old tree stumps should be burnt in winter. [J. C.] [F. V. T.]

Ceutorrhynchus assimilis (Turnip-seed Weevil) inhabits the flowers of the turnip and cabbage, and bores a hole in the incipient pods to lay its eggs in them. The maggots are found doing much mischief by feeding on the seeds. When they are full grown, they gnaw a hole in the pod, and, falling to the ground, bury themselves to construct cells in the earth, in which they change to ochreous pupæ with black eyes, and from these weevils issue. They are of a slate-black, clothed all over with very short white hairs; the proboscis is long and curved, the antennæ are slender and elbowed; there is a tubercle on each side of the trunk, and a grey channel down the back; a tooth under the hinder thighs, and the wing cases conceal a pair of ample wings.

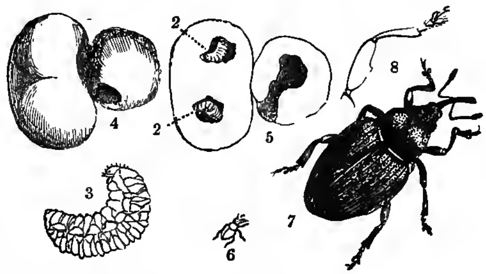


Turnip-seed Weevil (*Ceutorrhynchus assimilis*)

1, The weevil, natural size; 2, the weevil, magnified; 3, maggot, natural size; 4, maggot, magnified; 5, hole gnawed in pod of turnip; 6, pupal case; 7, pupa; 8, pupa, magnified.

C. contractus (the Charlock Weevil) is a much smaller species, which is bred from the root knobs of the charlock (*Sinapis arvensis*), and powerfully assists in injuring the young turnip crops by puncturing the leaves with its rostrum. It is from ¾ to 1 line in length, black with a coppery tinge; the wing cases are often green or blue, with punctured furrows, and lines of minute hairs between them.

Ceutorrhynchus sulcicollis (the Turnip-gall Weevil) causes the lumps upon turnips and swedes, and also cabbage. It deposits its eggs in the rind, which hatch beneath it and become maggots, forming galls which increase in size until the larvæ are full-fed, when they eat their way out, to undergo their transformations in the earth. In the spring the beetles hatch irregularly. Numbers also occur in early summer. From midsummer to September the life-cycle takes about fifty days, in spring sixty. The late broods remain in the larval stage into the winter, and even through it. The beetles are very similar to *C. assimilis*, but are shining black, thickly punctured, with a visible channel down the trunk; there are deep furrows on the elytra, with very short hairs between them, and *all* the thighs have a tooth beneath. The maggot is pearly white, footless, and curved, and with a brown head when full grown, and still lying in the nodular gall it measures ¼ in. The length of life of the maggot is very variable, it may be four or fourteen weeks. Land should be deeply ploughed after an attack and well rolled, and no crop liable to attack grown next season. Dressing with gas lime does good, especially after cabbage. All stumps of the latter should be burnt, and the young plant dibbled in with some soot and lime. The main thing to aim at is to feed off all diseased roots, deep ploughing, and the avoidance of a succeeding crop liable to attack. The rook feeds upon the maggots in the galls. [J. C.] [F. V. T.]



Turnip-gall Weevil (*Ceutorrhynchus sulcicollis*)

1, Gall formed by the weevil; 2, maggots in gall; 3, maggot, magnified; 4, 5, galls from which larvæ have eaten their way out; 6, the weevil, natural size; 7, weevil, magnified; 8, thigh of the weevil.

Chaff is a term often used very loosely, and applied to any dry, scaly leaves connected with flowers or fruit. Thus among Composite plants we find in a thistle head many dry scales placed between the flowers, and these are called chaff; the same thing occurs in Long-rooted Cat's Ear (Hypochœris) and in Chamomile (Anthemis). In such cases the appropriate botanical term for chaffy scales between the flowers is 'floral bracts', although other special names are often used. Again, in grasses, where the flowers are arranged in spikelets the term 'chaff' is applied to the pair of outer scales of the spikelet, which have no flowers in their axils, while the term 'husk' is usually confined to the pair of dry scales which enclose the grain fruit. The botanical name for each chaff scale or barren scale is *glume*, and for each valve of the husk round the fruit, *pale*. In sedges, the term 'chaff' may be applied to the protecting scale for the male flower, but the usual designation is 'glume'. In the genus of sedges called Carex two scales have to be dealt

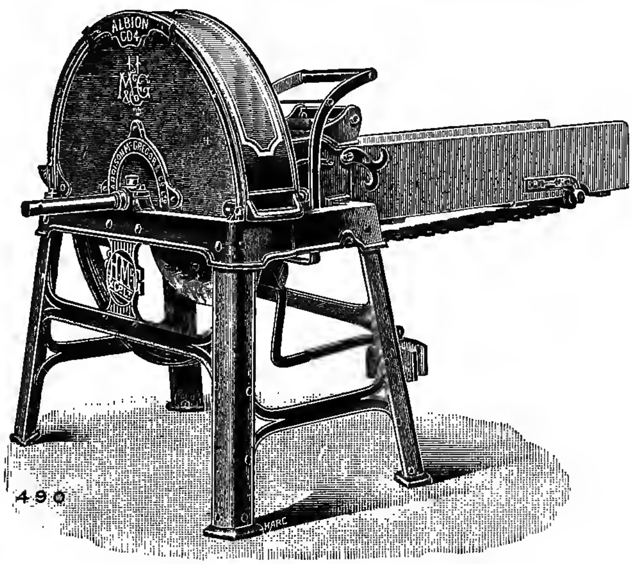
with—an outer flat scale which is barren, and an inner tubular scale which encloses the fruit. The outer barren scale may be called 'chaff', and the inner tube round the fruit 'husk'. In botanical works the barren scale is often called *glume*, and the inner tube round the fruit *perigynium*. It thus appears that much confusion prevails in the use of the terms 'chaff', 'bract', 'glume', and 'pale'. [A. N. M'A.]

The chaff of the cereal grains, consisting of the highly lignified and siliceous outer coverings of the grain which are detached and separated from it in the operation of threshing, is used in the preparation of mashes and for other purposes. It may also contain small corns and appreciable quantities of foreign matters, such as dirt, weed-seeds, spores of rust and other fungi, and must hence be used with caution for feeding purposes. Chaff has much the same composition as the corresponding straw, but is as a rule slightly richer in protein, appreciably poorer in crude fibre, and hence rather more easily digested than the straw.

Chaff may be used as a partial substitute for straw in rations for cattle, provided it be not unduly contaminated with foreign matters. If badly infected with disease spores it should be scalded or steamed before use, in order that they may not pass undestroyed into the manure, and thus re-infect the soil.

Oat chaff is the most nutritious, but is often not much relished by cattle. Barley chaff is relished by cattle of all ages, but owing to the roughness of the awns there may be considerable risk of inflammation of the walls of the mouth, throat, and stomach. Wheat chaff is little relished by any stock. Both barley and wheat chaff heat rapidly on storage, and hence cannot be kept for long periods. [C. C.]

Chaff Cutters.—Chaff cutters now used are almost universally of the type in which there is a wheel with radial arms forming the spokes and carrying curved blades or knives, set, except where there is only one blade, in such a way that the cutting is continuous and even as the wheel revolves. The cutting is effected as the knives pass by the face of the feed box, and they are so set as to run flush with the knife box. The capacity of modern machines is regulated by the width and depth of the mouth and the rate of feeding. Small hand-power machines with two knives, and mouth $7\frac{1}{2} \times 2\frac{1}{4}$ in., suitable for a small stable, will cut some cwts. an hour; while a steam-power six-knife machine, with $16\frac{1}{4}$-in. mouth, will cut up to 3 tons per hour. A five- or six-knife machine is capable of chaffing the straw into half-inch lengths as fast as it falls direct from an ordinary threshing machine; and over a large portion of the country the two operations of threshing and chaffing by one ordinary steam engine are commonly performed. There is great saving in this, as the straw falls from the shakers on to the chaff-cutter platform, and can be fed into the feed box by a mechanical feeder without further handling; the risk of injury from wet, and the probability of twisted straw through stacking being avoided. Those who are accustomed to work these larger machines find it difficult to realize why others use smaller machines. There is, of course, the greater initial expense; but where there is a considerable quantity of chaff required for feeding, there is undoubtedly economy in using the larger machines. All large machines are provided with means to convey the straw in the feed box to the knives, and the larger machines have an endless webbing running along the bottom of the box, and frequently a shorter one above nearer to the knives, while two sets of rollers compress and draw in the straw; to ensure a solid block of straw as it meets the knives, the upper part of the mouth is made self-acting, pressure being applied by a weighted lever; in the event of too heavy a feed, or the introduction of dangerous hard substances, a safety pin breaking when the load is too heavy stops the feed. By a necessary Act of Parliament the feeding must be mechanically performed in such a manner that the arm of the feeder cannot be brought into dangerous proximity to the knives. Riddles of various gauges take off coarse materials and sift out heavy dirt, and many machines are fitted with blasts or aspirators to clear out dust, so that a perfectly clean chaff is made. The chaff is conveniently bagged by being carried up by elevator to a suitable height for the sacks to be suspended to receive it; or tube elevators provided with a strong blast will deliver it into barns or lofts. No type of chaff cutter other than the



Chaff Cutter (Harrison, M'Gregor, & Co., Ltd.)

radial wheel knife is so profitable to use; and the smaller sizes are very valuable in circumstances suitable to their use, or where the power is insufficient to drive the larger. Some of medium size are fitted with effective means for cleaning and bagging the chaff, but the smaller are generally not fitted with attachments other than the knives. See next art. [W. J. M.]

Chaff-cutting Machines Act.—By the Chaff-cutting Machines (Accidents) Act, 1897, it is provided that every chaff-cutting machine worked by motive power, other than manual labour, shall so far as reasonably practicable be fitted with a contrivance to prevent the hand or arm of the person feeding the machine from being drawn between the rollers to the knives. The flywheel and knives must be kept sufficiently fenced during the working. Anyone contravening the provisions of the Act is liable to a penalty not exceeding £5, and in the prosecution of the owner of the machine, or the person for whose benefit it is used, if it is shown that the machine did not comply with the requirements of the Act, such person shall be deemed to have permitted the same unless he satisfy the Court he took all reasonable precaution to comply with the requirements of the Act. Any constable acting on the instructions of an inspector may enter premises to inspect a machine. [D. B.]

Chaff Fan, Chaff Basket.—The chaff fan is a convenient receptacle for holding and carrying chaff. It is shaped like the half of a mussel shell, and is constructed of finely split cane or willow wands worked on to a light basket frame; it is made to hold 6 or 8 bus. It is carried on one shoulder, the deeper end against the head, while the arm extended in a line with the body balances it. See BASKETS. [W. J. M.]

Chaffinch (*Fringilla cœlebs*, L.).—This familiar finch is easily recognized by its reddish-brown breast, white tail feathers, and the mixture of black, white, and yellow in its wings. Towards the end of April its beautiful cup-shaped nest of moss and feathers is built a few feet from the ground in the fork of a tree, or sometimes among ivy. The eggs are usually five in number, and are greenish in colour with purple blotches. The bird feeds on the ground in fields and gardens, doing mischief by devouring sown seeds, particularly those of oily nature, and destroying seedlings, cruciferous ones being preferred. In spring, on the other hand, it devours many injurious insects, with which its young are fed, caterpillars being mostly chosen for this purpose. Flocks of chaffinches haunt the fields during the autumn and destroy many weed-seeds. Good and evil are effected in about equal proportions, and the most that should be done is to keep down undue numbers. [J. R. A. D.]

Chain, a measure used in surveying. The chain itself consists of a hundred links, made of strong steel wire, and furnished with a handle at each end. Two chains are commonly employed—*Gunter's Chain*, which is 66 ft. long, each link thus being 7·92 in. in length, and the *Hundred Foot Chain*, in which each link is 1 ft. long. The former is nearly always used in land measurement, while the latter is more frequently employed by railway engineers. See also SURVEYING.

Chain Harrows. See HARROWS.

Chalcididæ, a family of minute parasitic Hymenoptera, the majority of which lay their eggs in the eggs and larvæ of other insects. Many are singular in form and brilliantly metallic. All groups of insects seem subject to their attack. [F. V. T.]

Chalder, a Scotch dry measure formerly employed in weighing grain. It contained 16 bolls, or 96 imperial bus., and is still used in fixing the stipends of ministers of the Church of Scotland. See also TEINDS.

Chalk, Chalking.—Pure chalk is of the same chemical composition as pure limestone. Both are forms of carbonate of lime ($CaCO_3$), and differ only in physical properties, limestone being hard and compact, while chalk is loose in texture, and is rapidly weathered into a powder when spread on the soil. The application of chalk to land is a method of land improvement practised in the south of England and on the Continent. The chalk is either dug up from the subsoil or brought from a distance, and is usually applied late in autumn in time to let it be acted upon by the winter frosts. The chalk is spread on the land, without any previous preparation, the larger lumps not even being broken, as the action of weathering and harrowing in spring reduce it to a sufficient state of fineness. The quantity applied varies from 8 to 30 tons per acre, according to the demand for lime by the soil, and even larger dressings are applied to stiff clay soils. The following are the chief advantages of applying chalk to soils: (1) It ameliorates the physical character of both light and heavy soils; (2) it supplies a necessary plant food; (3) it corrects any acid tendency in the soil and promotes nitrification. See art. CALCIUM COMPOUNDS ON SOIL, AND LIME. [R. H. L.]

Chamois.—This animal is known scientifically as *Rupicapra tragus* (meaning a rock goat), owing doubtless to its resemblance in some respects to the genus Capra, and is classed by naturalists with the antelopes. It is said to be the only antelope found wild in Europe, and is met with in the Alps, the Pyrenees, the Carpathians, the Caucasus, and other mountains. It stands about 38 in. in height, and carries a thick coat of hair, which varies in colour according to the season of the year, being a dark-grey in spring, yellowish-fawn in summer, and brown in winter. The face is at all times characterized by a dark marking extending from the corner of the mouth to the base of the horns, encircling the eye. Both the male and female have horns, but are without beard, differing in this latter respect from the male goat. The horns are black, measuring from 5 to 7 in. in length; they rise almost perpendicularly from the head, but when about 2 in. from the tips curve somewhat sharply to the rear, forming a pair of hooks. This latter part is smooth, but the lower portion has vertical indented lines traversed by faint annular rings. The bleat of the Chamois resembles that of the

goat, but is more husky. When alarmed it gives through its nostrils a peculiar whistling sound, which is intended as a warning of danger. The female carries its young six months, and has seldom more than one at a birth; the breeding season being from May to June.

The Chamois is remarkable for its agility, and the astounding manner in which it can secure a foothold on the narrowest of ledges and the most pointed of rocks. When pursued it can jump to an extraordinary height, and bounds down the most frightful precipices at breakneck speed. Chamois hunting in the Alps is a sport that is much less practised of late years owing to the comparative scarcity of the animal, which, to prevent its extermination, is now protected by law. The skin when dressed is extremely soft and supple, but what is commercially known as chamois or 'shammy' leather is generally prepared from the skins of sheep, goats, deer, and other animals, which are dressed under the same process as that originally employed with those of the Chamois.

[H. S. H. P.]

Chamomile.—Chamomiles are plants belonging to the nat. ord. Compositæ, bearing daisylike heads of flowers having a white ray and a yellow disk. Unlike the daisy, the leaves are cut up into numerous fine segments as shown in the figure. True Chamomile (*Anthemis nobilis*) is a downy perennial which grows in pastures and dry soil. The shoots do not stand erect, but are prostrate along the ground, and bear leaves cut up into fine segments, which emit a strong and characteristic odour when bruised. At the end of the shoot is the daisylike flower-head. If the florets are pulled out of the head, obtuse chaffy scales are found among them; no such scales occur in daisy heads. The flower-heads of this Chamomile, usually of the double variety, are sold in shops as Chamomile flowers. Stinking Chamomile (*Anthemis Cotula*) is an erect bald annual weed with a fœtid odour, which grows among corn and on waste ground. Its shoots are 1 or 2 ft. high, and bear leaves cut up into fine segments; from these bald leaves, especially when bruised, the fœtid odour comes out strong. At the end of the shoot is the daisylike flower-head borne on a long stalk; as before, chaffy scales occur among the flowers, but in this case the scales are sharp-pointed, not obtuse. The white flowers are purely ornamental, as is evidenced by the absence of the style. Since Stinking Chamomile seeds freely it may become a troublesome weed; accordingly seeding should be prevented by removing the plants before flowering. Corn Chamomile (*Anthemis arvensis*) is also an erect annual weed, but hoary from its covering of minute silky hairs, and almost destitute of scent. In other respects this closely resembles Stinking Chamomile.

Wild Chamomile (*Matricaria Chamomilla*) is very like the True Chamomile, but is readily distinguished by being an annual, and not prostrate but erect, as shown in the figure; the scent also is very slight or absent. There is a further difference in the construction of the head: a True Chamomile (Anthemis), as in fig. 1, bears flowers (*f*) as well as scales (*s*) on the axis (*a*) of the head; whereas a Wild Chamomile (Matricaria), fig. 2, bears only flowers (*f*) on the axis of the head, and wants the scales, unless perhaps at the base of the outermost florets. The *hollow* conical axis, and the head *destitute of scales*, suffice to distinguish wild from true Chamomile. [A. N. M'A.]

Wild Chamomile (*Matricaria Chamomilla*)

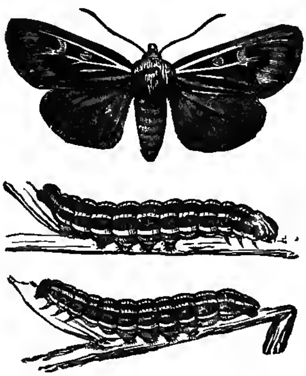
1, Flowers and scales of True Chamomile. 2, Flowers of Wild Chamomile, with basal scale only.

Channel Islands Cattle.—This term comprises the Jersey and Guernsey cattle. As the two breeds are entirely distinct, this nomenclature only led to confusion, and has therefore been abandoned. See JERSEY CATTLE and GUERNSEY CATTLE.

Character of Servant. See MASTER AND SERVANT.

Charæas graminis (Antler Moth) sometimes causes the destruction of pasture land to a considerable extent in mountainous districts, by the caterpillars feeding mainly upon the roots of the grasses. These were most harmful in Glamorganshire in 1884, and in 1885 in Sel-

kirkshire. They are 1 in. long, smooth, and of a dull-grey colour, with three yellow lines down the back and sides. Maturity is reached about midsummer, when they often leave their subterranean abodes in search of some eligible spot to change to pupæ, which they do in slight cocoons, under ground, in moss, under stones, &c. Most pupate in the ground. The larvæ feed at night and hide by day. They live through the winter and feed again in spring, pupating in June. The moths hatch in four or five weeks, and are of various tints of brown, with pale



Antler Moth (*Charæas graminis*) and Caterpillars[1]

areas on the upper wings, like the antlers of a stag. The antennæ of the male are pectinated, and the wings expand a little over an inch, those of the female 1½ in. The eggs are laid in July and August, and hatch in three weeks. The only treatment seems to be firing the surface, so as to drive the caterpillars into some stream or obstacle, and in small attacks turning pigs on infested land. [J. C.] [F. V. T.]

Charcoal and Charcoal Burning is one of the most ancient of British woodland industries, and was of great importance before coal was used for iron smelting, though the last of such charcoal iron furnaces was not shut down till 1809 (at Ashburnham, Sussex). Between 1558 and 1585 three special Acts were passed to prohibit timber trees of oak, beech, or ash being made into charcoal, and to protect other trees in woods and coppices. But even throughout the greater part of the 19th century many industries (powder factories, glassmakers, blacksmiths, &c.) still used charcoal to a far greater extent than is now the case. Thus, while in olden days charcoal burning was habitual on all largely wooded estates, it is nowadays only practised extensively in the Forest of Dean (Gloucestershire) and in some parts of the Midlands. Elsewhere it is chiefly continued to use up for estate and smithy purposes the surplus lop, top, and waste wood not needed as household fuel.

Charcoal can be made from any kind of wood, but the finest quality, used for making gunpowder, is that furnished by the alder-buckthorn and dogwood shrubs, and by alder. Charcoal burning is the dry distillation of wood by means of carbonization under partial exclusion of the air in pits, kilns, or stacks; but charcoal is also now largely obtained as a by-product in the treatment of wood in masonry furnaces or iron retorts for the purpose of producing crude pyroligneous acid or wood-vinegar (at a temperature of 300° to 550° F.) and wood-tar (Stockholm or Archangel tar, at 625° to 800° F.). In the former process there is, of course, a greater loss of carbon through partial combustion, owing to the atmospheric oxygen being very incompletely excluded, for after the water contained in the wood is gradually driven off as vapour on the boiling-point (212°) being reached, decomposition of the woody substance itself begins at about 300°.

Good charcoal should be deep-black in colour, with a steel-blue metallic sheen, and lustrous across the transverse surface; and it should keep its colour and emit a metallic sound when two pieces are clinked together. Charcoal of a reddish-brown 'foxy' colour is incompletely carbonized, while softness and dull colour show that it has either been made from unsound wood or overburned. The sp. gr. of charcoal is about 0·20 on the average; but hardwoods produce heavier and better charcoal than softwoods, and well-seasoned wood more than green wood; large split billets yield more than small branchwood; and the slower the process of carbonization the heavier is the charcoal. Good kiln-burned charcoal should yield from 50 to 60 per cent of the volume of the wood used, and roughly about one-fourth of its original weight; and it usually weighs about one stone a bushel. A ton weight of wood will produce about 40 bushels on the average, but only 36 if hardwoods alone be used, and about 43 if softwoods be used. These average figures are apt, however, to vary greatly according to circumstances. The cost of making charcoal is about 1*d.* a bushel or 13*s.* 4*d.* a ton, and the selling price is about 60*s.* a ton. As 4 tons of wood or small stacks of cordwood will give about 1 ton or 160 bus. of charcoal, this would fix the value of the wood plus the profit on the preparation as equal to 46*s.*, or 11*s.* 6*d.* per cord of 1 ton. But where charcoal burning is still carried on as a regular business, the cordwood is sold to the kiln-men at a price which often enables them, working in pairs, to earn about 35*s.* to 40*s.* a week each.

The oldest British method of charcoal burning is the primitive and wasteful system of preparing it in pits dug 3½ to 4 ft. deep in the ground, with sloping walls. After being filled with brushwood and small branches this is set alight, and on the smoke clearing away the charred mass is stirred up and wood thrown in, and so on at intervals till the pit is entirely filled up, when the whole is covered with turf and earth, and then allowed to cool down for a day or two before being opened to take out the charcoal. But this old rough method only gives about 30 bus. per cord of 128 cub. ft. The customary British method now long practised in English woodlands is the improved system of charcoal

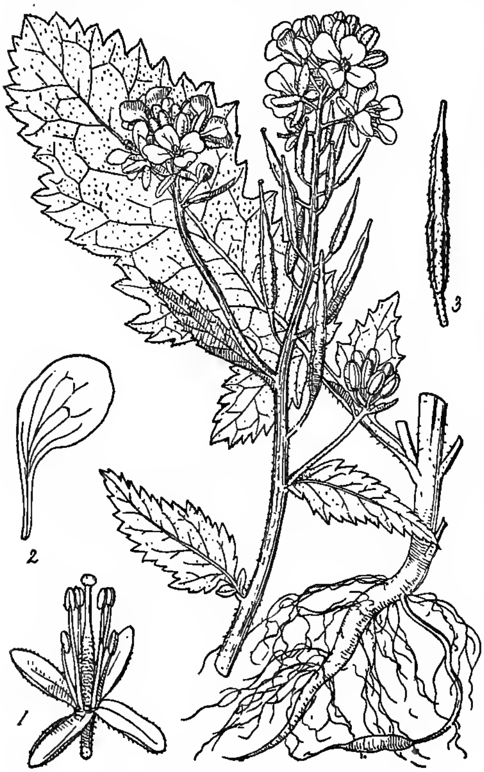
[1] From Ormerod's Manual of Injurious Insects.

burning in dome-shaped kilns. The wood being collected and prepared in billets of 15 or 18 to 24 in. long, kilns or stacks are formed about 12 to 15 ft. or more in diameter. The hearth being levelled, a large pointed billet split crossways at the top end is fixed in the centre, and two bits of wood are inserted at right angles through the clefts in the upper end. In each of these angles a billet of wood is placed thick end down leaning against the centre post, and large straight billets are laid radially on the ground like the spokes of a wheel to form a floor, and the spaces between are filled with small brushwood or branches. To keep these billets in proper position, pegs are driven into the ground round the circumference of the hearth and about 1 ft. apart. On this floor the first stage or story of the kiln is built, with the largest billets set thin end up and inclining slightly inwards towards the central stake; and over these another story or layer of shorter billets is laid; and so on, till the whole forms a sort of paraboloid cone. It is then covered with turf and the surface is faced with mixed earth and sand. To light the kiln the central billet in the upper layer is drawn out, and pieces of dry combustible wood are inserted and set alight. Great attention has to be paid both by day and by night to regulate the course of the firing, and to prevent unnecessary combustion by immediately closing any apertures through which flame obtrudes. The burning generally takes about four or five days, according to the size of the kiln and other circumstances. When the colour of the smoke and the absence of flame from the air holes show that the charcoal seems ready, all the vents are carefully closed with mixed earth and sand to exclude atmospheric oxygen and prevent further burning. The fire then dies down, and the kiln is allowed to cool before the covering is removed and the charcoal taken out. The cubic contents of such a cone-shaped kiln can be easily estimated roughly if the actual quantity of cordwood used is not known. As the contents of a paraboloid cone and of a true cone are respectively one-half and one-third of the basal area multiplied by the height, about $\frac{4}{9}$ (basal area × height) will give the actual cubic contents; and as the circumference is easiest to measure, this will give the formula = square of circumference multiplied by the height and divided by 9π (28·27).

The most common Continental method of charcoal burning in dome-shaped kilns is in many respects very similar to this customary British system, though the hearth is not prepared with any flooring of radiating billets (except in the Alpine or Italian method, in which billets of 6 ft. long and up to over 15 in. diameter are built up into kilns of from 5000 to 10,000 cb. ft. or more in contents). Throughout Central Europe the upright paraboloid kilns are usually formed with billets about 3 to $3\frac{1}{2}$ ft. long and from over 1 in. at top end up to a large girth, those over 6 in. diameter being split through once or oftener and trimmed to make them of convenient size to pack closely. When only temporary hearths are used the kilns are generally from 700 to 1200 cb. ft. in contents, but on permanent hearths to which the wood can be brought they are usually of 2000 to 3500 cb. ft.; for the larger the kiln the cheaper is the production, though small kilns are easiest to make and to manipulate. If possible, the kilns are made of one kind of wood only, to prevent unnecessary combustion of the softer and lighter among several kinds, and so far as possible of billets about equal size. But where differences must occur the larger and heavier billets are placed about midway between the centre and the circumference, as it is there that the heat soon becomes greatest. If possible, only well-seasoned wood is used, as damp wood takes longer to prepare, burns more irregularly, and yields less charcoal. The successive stages in the operations consist in preparing the hearth; building, covering, and lighting the kiln; regulating the course of the firing, filling in parts that shrink and sink, and watching the kiln till it has cooled down; then breaking up the still-warm kiln and assorting the charcoal according to size. The hearth should be level, but made to slope slightly from the centre outwards, sheltered from wind, and with plenty of water near; and an old hearth draws better than a new one. In building the kiln an upright central vent is first made as a lighting flue by erecting three or four arm-thick poles about 1 ft. apart in the centre and binding them with withes to form a receptacle to be filled with inflammable chips, half-charred wood, &c., and similar material is packed round this central flue. If the kiln is to be lighted from above, the billets are now so ranged and built up as to form a paraboloid cone rising at an angle of about 60°; but if lighting is to be from below (as is usual), then a 5- or 6-in. pole is laid on the ground from the centre to the circumference, and as the kiln is being built up this pole is gradually withdrawn, thus leaving a clear passage for inserting a long straight rod with lighted wood chips to set fire to the matter in the central flue. To equalize the carbonization, big billets are set split face inwards, those of largest size being built up in the middle portion halfway between the centre and the outside, where the heat becomes greatest. The kiln is first covered with a layer of turf, moss, bracken, conifer sprays, &c., and is then given a top-covering of earth and charcoal 'breeze' to exclude the air. This covering may vary from 2 or 3 up to 8 or 10 in. thick according to circumstances, and is kept in rest by supports near the base; and unless the place is sheltered a wind-screen has to be formed of brushwood. After the kiln is well alight it 'sweats' thickly, and if the hearth be very porous and the covering insufficiently so, there is now a danger of the moisture in the wood becoming converted too rapidly into steam and causing an explosion. In an hour or two carbonization begins and the smoke becomes pungent and acrid, but sweating continues for about twenty to twenty-four hours in all. About twelve or sixteen hours after lighting, all shrunken places have to be filled up with new wood as quickly as possible, which always means a certain amount of wastage; and

when the sweating is ended smoke-holes or air-vents have to be opened with a pointed stick to regulate the course of the carbonization (as may be known by the white colour of the smoke). The chief art in charcoal burning is the manipulation of these smoke holes. When carbonization is completed right down to the outer edge of the kiln all the vents are closed, moist earth is thrown over the kiln, and it is allowed to cool down for twenty-four hours before the drawing of the still hot charcoal begins, which is sprinkled with water to prevent its glowing again. Then it is assorted into foundry and smithy charcoal, while the smaller pieces are screened and also assorted. Charcoal burning is now everywhere throughout Continental Europe a decadent woodland industry, through the rise of the new wood-pulp and cellulose industries for papermaking. [J. N.]

Charlock.—In botanical works this plant is called *Brassica Sinapis*, *Brassica arvensis*, or



Charlock (*Brassica Sinapis*)

1, Flower (petals removed); 2, Petal; 3, Fruit.

Sinapis arvensis. It belongs to the same nat. ord. as Turnip, Cabbage, and Mustard, namely Cruciferæ. Charlock is a very pestilent annual weed on light, arable land, particularly in corn crops. It is pestilent in various ways, for not only does it harbour the parasitic organism *Plasmodiophora Brassicæ* which causes the finger-and-toe disease in turnips, but it interferes to a very considerable extent with the yield of corn per acre. The seeds also may lie buried in the ground for years and suddenly, when turned up to the surface, begin their interference with the crops.

Two yellow-flowered annual mustard weeds are often confounded, namely Charlock proper and the Wild Radish or Runch (*Raphanus Raphanistrum*). Attention to the following points of difference renders distinction easy. The leaf-blades of Charlock are comparatively simple, whereas those of Runch are divided and lobed. The sepals of the Charlock flower are spread out horizontally, but those of Runch are erect and close together. When in fruit, the long Charlock pod opens by two valves and allows the seeds to fall out, but the Runch pod never opens; instead, it breaks crossways into jointed pieces like little morsels of straw. Each of these pieces contains one seed. Charlock sows seeds, Runch sows pieces of its pod.

In the seedling stage, too, it is important for the turnip weeder to distinguish the young turnip plant from the young Charlock weed. In Charlock, the first green leaves which come after the heart-shaped seed-leaves are about twice as broad as long, whereas in Turnip the corresponding leaves are nearly equal in length and breadth. The seed of Charlock, like that of Turnip, takes the form of a tiny globe with a dark-brown colour. These seeds are not easy to distinguish from those of Turnip, unless when they are bruised and wetted, as is the case when we chew them in the mouth. The Charlock seed now tastes of mustard, for a chemical change has taken place, and the volatile biting mustard oil has been produced. No such change takes place in Turnip seed, and the taste is bland and oily; there is no trace of mustard here. At times Charlock seeds are incorporated as adulterants in 'rape cake'. If such 'cake' is used, the insides of the cattle are liable to be blistered by the internal mustard poultice. The spraying of cereal crops with a solution of sulphate of copper or 'bluestone' is now extensively adopted for the destruction of Charlock and Runches. See SPRAYING. [A. N. M'A.]

Charlock Sprayer. See SPRAYER.

Chartley Cattle, a herd of wild white cattle which up to the year 1901 were enclosed in Chartley Park, Staffordshire. See WILD WHITE CATTLE; also art. CATTLE.

Chats.—Potatoes under seed size are known as 'small' or 'chats'.

Chats.—These are small insectivorous birds belonging to the Thrush family. All of them are beneficial, and should on no account be molested. Three common British species require notice.

1. WHEATEAR (*Saxicola œnanthe*, L.).—This migrant form, which stays with us from early March to the beginning of October, is easily distinguished by its white rump and throat, and the black colour of the sides of its head; also by the habit of jerking the tail up and down. The males arrive before the females, and are first to be seen in the south-west of England. The loosely built nest is built in a hole in a wall or rock, or in a rabbit burrow, the materials

used being coarse grass, lined with finer grass and fur. The six or seven eggs are of a very pale-blue colour.

2. WHIN-CHAT (*Pratincola rubetra*, L.).—This species is also a migrant one, arriving in mid-April and departing early in October. A white spot on the wing and a white line over the eye are distinctive. The bird frequents open fields and pastures (waging unceasing war on wire-worms), and builds its nest of moss and fine grass soon after arrival, generally on or near the ground, beneath a furze bush or tussock of grass. The six or seven eggs are of a pale-greenish-blue colour. There may be two broods of young in a season.

3. STONE-CHAT (*P. rubicola*, L.).—Unlike the two preceding species this one is resident, and during the winter its numbers are largely augmented from the colder parts of the Continent. It resembles the Whin-chat in appearance, but the head is entirely black, and the wings are barred with white. The nest also resembles that of a Whin-chat, but is rather more carefully constructed. It is built in early April, either on the ground or in a bush of furze or bramble. The six eggs are of a green-blue colour, and there may be two broods of young in the year. Flocks of stone-chats wander about cultivated country in the autumn, conferring great benefit upon the farmer by destroying injurious insects and their larvæ. [J. R. A. D.]

Cheddar Cheese.—It may be stated with confidence that for the production of a high-class 'hard' cheese of a typical English character, and for adaptability to all sorts of soils and climates where dairying can be usefully practised at all, the Cheddar is the best of all systems of cheesemaking so far evolved. The Cheddar is an ancient cheese. It can be traced to the time of Camden, who wrote in the days of Queen Elizabeth, and for three centuries earlier. Records going back beyond that period are not at present forthcoming. In appearance, in shape and size combined, it has no rival but the equally ancient Cheshire cheese. Writing in the 17th century, Fuller said that the worst fault of Cheddar cheese was its high price and scarcity: it was 'hardly to be met with, save at some rich man's table'. This is high testimony to the favour it enjoyed in those days.

Cheddar and Stilton cheese each took its name from a certain village; but whilst the advent of Stilton did occur within historical times, the coming of Cheddar did not. Although it is the most piquant and blue-blooded of English cheese, Stilton is less famous, as it is less widely distributed in the great cheese marts of the world. Cheddar was apparently a specialty confined to the place of its earliest production, and its method of manufacture was probably kept a secret as long as possible, as was certainly the case with the Stilton. And in both cases, once they were no longer secrets in the art of dairying, the systems respectively employed were soon copied and duplicated to an extent and with a celerity hardly met with elsewhere in the wide domain of dairying. Dormant as the Cheddar system was for centuries, so far as enterprise was concerned, and isolated, from choice or necessity, its vitality was prolific and extraordinary once it had a free hand to convince the nations. For a while it was claimed that only the fat pastures of Somerset, and of one or two adjacent counties, could produce the highest qualities of Cheddar cheese. As a matter of fact, however, its adaptability to all sorts and conditions of herbage, of climate, and of cattle was soon proved in America and elsewhere, in a manner that astonished and alarmed many dairy farmers in Great Britain at the time.

Few men have conferred, or have had a chance of conferring, on Scotland a material benefit equal to that of Harding of Marksbury, when he introduced the system of making Cheddar cheese into the south-western counties. He was commissioned to lay the subject before the farmers of Ayrshire, and in an address delivered in 1854 in that county he uttered this remarkable declaration: 'Cheese is made in the dairy yonder, where A is feeding his kine on broad clover, tares, and rye grass; or where B, on the edge of the moor, is making what was almost desert blossom as a rose with the varied arable forage crops of a first year's cultivation; or yonder again, where C and D are managing old carse farms in the groove first made generations ago. I will take the milk from any of them and make the same cheese anywhere. Cheese is not made in the field, or in the byre, or even in the cow—it is made in the dairy.' However, Harding's words must not be taken in a cosmopolitan sense, but in a local one only, in application to the district in which they were spoken. As a matter of fact, he believed that in connection with different soils and districts and systems of farming, a change in the dairy was necessary, 'involving some little alteration in the routine of manufacture, but leaving untouched the main points of the Cheddar process'. These quotations fairly represent, as far as they go, the state of expert knowledge about cheesemaking at the time, say 1860–70. Harding was the most famous maker of his day, or the shrewd farmers of Galloway had not sent for him to teach them a new and better way of turning milk into cheese. And the system he had learned and practised in his native Somersetshire was competent to produce excellent Cheddar cheese not in southern England only, but in southern Scotland too. Be this as it may have been at the outset, Harding took the Cheddar system up into Scotland, and Scotch dairyers have amply vindicated the faith that is in them on the subject by repeatedly winning the chief Cheddar prizes in the world's greatest dairy show, held in London. It has for years been unquestionable that cows and climate and rotation pastures in Scotland can well compete on even terms with the grand old permanent pastures of Somerset, and sometimes beat them hand-over-hand in the dairy shows.

Harding had declared his abounding confidence in the actual and potential merits of the Cheddar system, but his ideas as to what fundamental principle those merits were owing to were vague and nebulous, as indeed were everybody else's fifty years ago. He knew that the salient feature

of the system was the introduction, or development, of *acidity* in the curd, by first impregnating the milk with acid whey according to the practice of early makers. But he did not know —nor did anyone else at that time—how and why it was that acid whey played so important a part in the process. He employed the whey of the previous day, in whose lactose the lactic acid bacilli had prodigiously multiplied in number, but he was not aware that all the success he achieved was owing to the action of the lactic acid bacillus. The theory of this natural action in the curd of milk did presently open out a new world, as it were, to the students who were taking up dairying as an art and a business. It was obvious—confirmed by long experience — that 'acid', as it was generally called, had a beneficial influence on the cheese, but the why and wherefore of this was only conjectured, if even that. Its use, discovered accidentally as we may assume, was to expedite the process of making cheese, and of the ripening in due course. This much was known for centuries, and it had been discovered that whilst this 'acid' was a useful servant, it was a merciless master. It was apt, too, like many other subordinate things, to usurp the position of master, once it saw a chance of doing so. But it was left for our day to solve the problem, and to reveal the nature and character of this valuable ferment.

In the meantime the system has been adopted more or less in all great dairying countries where cheese is made at all. It is universal in the colossal installations of co-operative cheesemaking in Canada and in the great republic on the south. It is doing good service in Australia, New Zealand, and elsewhere in the British Empire, and it has made its way in many countries outside. Canada is now the chief exponent of the system, and likely to remain so, though in course of time Australia will be a keen competitor. The system in practice has, wherever it has had a fair chance, borne out all that was claimed for it in early days, when science was beginning to interpret its mysteries. It has made itself at home, as no other system could have done, in all lands well adapted to dairying. And all this was owing to the predominant part which lactic acid took in the process. This ferment indeed is indispensable in regard to cheesemaking generally, and also to buttermaking. See next art. [J. P. S.]

Cheddar Cheesemaking. — Cheddar cheese is a rich and sustaining food. Speaking generally, it is composed of about equal parts of fat, casein, and water, with small proportions of sugar and mineral matter; so that in the manufacture of Cheddar cheese from cow's milk the water in the medium is reduced from about 87 to about 33 per cent. In practice the removal of moisture is effected by first rendering the casein insoluble by the action of rennet. The casein precipitates in the form of a clot, which mechanically holds most of the fat globules and allows much of the water to separate out. The following table (Richmond's) shows the distribution of the various constituents of milk when made into curd and whey:—

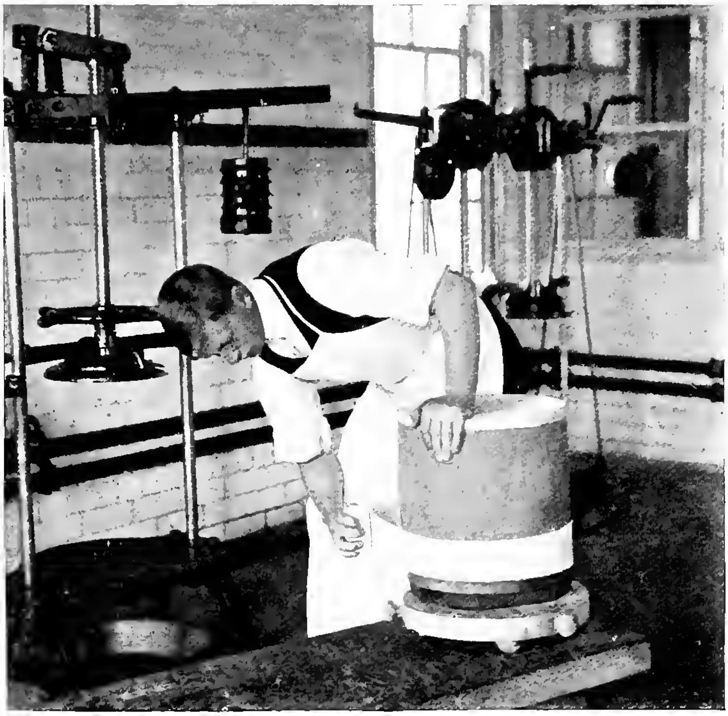
	Milk.	Whey.	Curd.
	Per cent.	Per cent.	Per cent.
Water	87·10	80·60	6·50
Fat	3·90	·30	3·60
Milk sugar ...	4·75	4·45	·30
Casein	3·00	·40	2·60
Albumin ...	·40	·40	trace
Ash	·75	·60	·15

The milk is partially fermented, naturally, or by the use of a special ripening agent termed a 'starter'. Extract of rennet, which contains coagulating and digesting enzymes, is added, and the milk coagulates or curdles. The coagulum is cut into small cubes, and a watery serum or whey gradually separates out, the solid residue or curd diminishing in bulk. The draining of moisture from the curd is promoted by the action of heat from an external source, and by the acidity which is developed in the milk and curd during the process. When sufficiently cooked and partially fermented the curd is removed from the body of whey, further ripened, and finally salted. The salted curd is pressed in moulds to remove more of the moisture and to consolidate it into a close uniform mass of the desired shape and size. The curd obtained thus, by coagulation, has been rendered insoluble and indigestible, and in this state is of little value as food for immediate use. Yet there is present in the curd digestive enzymes and the conditions necessary for their action, so that when the 'green' cheese is kept in a curing room at a suitable temperature a gradual ripening takes place. During this period the tough, indigestible, and insipid curd becomes partially digested, and changed to a soft plastic mass, with the characteristic pleasing flavour and odour and high nutritive qualities of good Cheddar cheese.

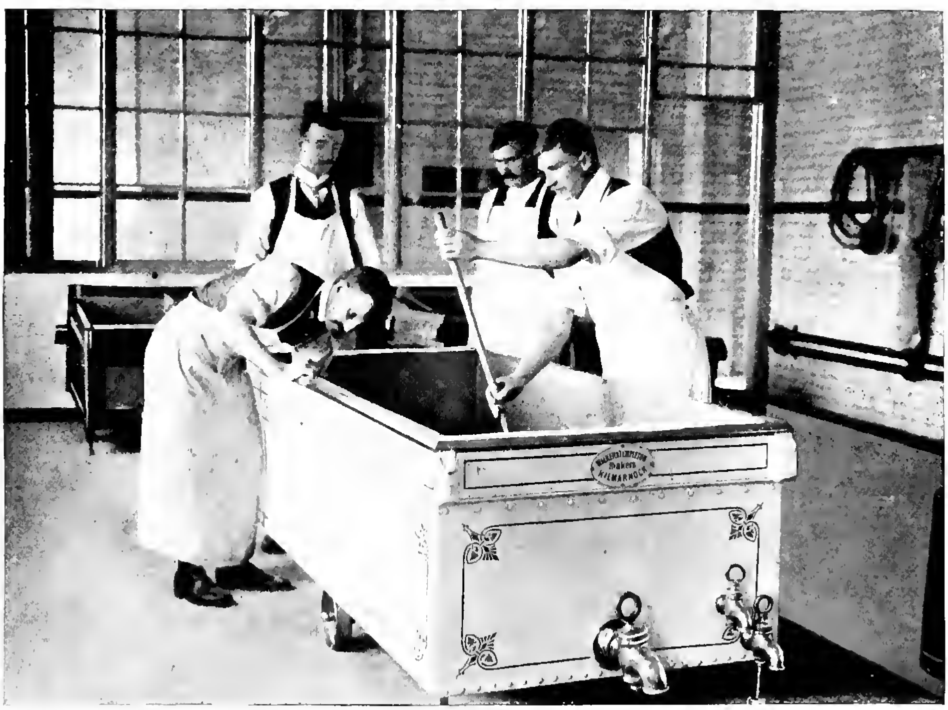
Quality in a Cheddar cheese refers to the flavour, texture, colour, and outward appearance generally. The following is the scale of points of merit adopted by the Ayrshire Agricultural Association at their great annual cheese show at Kilmarnock: Flavour, 40; body and texture, 40; colour, 12; appearance and finish, 8. In a good Cheddar the flavour is mild and pleasing rather than strong and acidy. It can be described only as a characteristic Cheddar cheese flavour. The texture is smooth and close, comparatively free from all forms of openness. It is moderately dry yet not crumbly, and plastic yet free from stickiness. The colour varies in intensity according to the demand of the particular market, but is bright and uniform throughout, not mottled or discoloured in any way. The appearance and finish refer only to the exterior. The cheese is symmetrical in form, of a fashionable shape and size, and has a smooth clean surface and neat edges, so that the appearance generally is neat and attractive.

The making of cheese may be a very simple process, accomplished by anyone without special training and with only crude appliances. To a certain extent it is a natural process. If comparatively fresh milk is treated with rennet and the whey removed in some degree from the curd,

CHEDDAR CHEESE MAKING



METHOD OF BANDAGING



STIRRING THE CURD IN THE WHEY

the product will mature according to the conditions incidentally present in the substance and its surroundings. Many fine cheeses have been made when the maker had no clear conception of the agencies that were acting to produce it, or the principles according to which the desirable features were developed. But for the making of *uniformly fine* Cheddar cheese, the maker not only requires a knowledge of all the practical details which make up the classified system, but must understand clearly the principles upon which the Cheddar system is founded. He must have some knowledge of the sciences which have a more or less direct bearing on the subject. It is only then that he is able to cope successfully with the tendencies to variation in the quality of the product, due to the continually varying external conditions. No two Cheddar cheeses are made under exactly the same conditions and receive exactly the same treatment; so that, besides technical training, much practical experience is necessary before the maker can claim to be even moderately well trained. The best training for a maker is obtained by spending one or two years at an agricultural and dairy college, giving attention during the winter to the general class work, and during the summer doing practical work in the dairy school. The benefits to be obtained are well exemplified by the success of those who have enjoyed the advantages of such a training. In the following pages we shall try to explain as clearly as possible some of the principles of Cheddar cheesemaking, and some of the practical details of the process.

For Cheddar cheesemaking special buildings are necessary. The first essential for all properly constructed dairy buildings is that they are constructed so as to be easily cleaned and kept in fresh condition. Of the farm dairy buildings the byre is perhaps the most important. To have healthy cows, giving pure sound milk, we must have a byre constructed on sanitary principles, with adequate air space, ventilating and lighting accommodation, and a floor at once impervious to moisture and easily cleaned. In well-equipped dairies there are at least three apartments for cheesemaking—the making room, the press room, and the curing room. The curing room is frequently over the other compartments, and if so, must be provided with a ceiling to protect it in some degree from rapid variations in temperature. The curing room is kept moderately dry and well ventilated. It is provided with arrangements for regulating the temperature, preferably steam or hot-water pipes. It is also fitted with turning shelves, so that several shelves with their contents of cheese can be turned round together on an axle. This method of turning protects the surface of the cheese from injury and saves much time and labour. The floors of dairy buildings, with the exception of that of the curing room, which may be of wood, are usually of best concrete, with a smooth surface, sloping slightly towards one side, along which runs a small surface drain to an opening in the wall, through which it communicates with a covered drain outside, the latter being well trapped. The walls are as smooth and free from crevices as possible, often lined with cement or enamelled tile so that they can be frequently washed. The ceilings are usually plastered. The making room is provided with adequate supplies of steam, and hot and cold water, and with facilities for conducting away the waste water and whey. The steam boiler or other heating apparatus is situated so as not to interfere unnecessarily with the temperature of the making or curing rooms. See Buildings, Farm.

The utensils required in Cheddar cheesemaking are numerous. They include, besides the ordinary milk pails, coolers, shallow pans, &c., a milk vat capable of receiving the whole milk of one day, milk and curd strainers, dippers, dairy thermometers, measuring glasses, acidimeter, testing iron, perpendicular and horizontal curd knives, curd rake, curd brush, curd cooler with draining racks, draining and cheese cloths, curd mill, curd shovel, cheese moulds, hoops, or chessets, cheese presses, salt scales, and a small weighing machine. The agents employed in the making of cheese include rennet, starters, acidity, heat, moisture, annatto, salt, and pressure. As several of these will be treated of elsewhere, we shall refer here only to their direct connection with Cheddar cheesemaking.

Rennet is the agent universally employed in cheesemaking to coagulate the milk. Extract of rennet contains as its chief constituents the enzymes 'rennin' and 'pepsin'. The action of the rennin enzyme on milk is to cause the casein, which is present in partial solution as a compound of lime, to undergo a fermentation whereby it is rendered insoluble, and precipitated in the form of a clot. This clot mechanically encloses and holds most of the fat globules, and the casein and fat with a proportion of water form the curd. As we shall see later, the pepsin introduced in the rennet has a very direct connection with the maturing of curd into ripe cheese. Rennet, like other enzymes, is influenced in its action by temperature. The optimum temperature for coagulation by rennet is about 106° F. Near this temperature the curd produced is firm, at lower or higher temperatures soft and flocculent. The temperature of the milk when renneted is usually about 84° F., so that within these limits the higher the temperature of the milk during coagulation the more rapidly the curd will form. The action of rennet is influenced also by the chemical reaction of the milk. Rennet acts only in neutral or acid solutions, and the greater the acidity the more rapid its action. Thus in cheesemaking ripened milk gives a firmer coagulum in a shorter time than perfectly fresh milk. Rennet does not coagulate properly milk which has been pasteurized; the pasteurizing of milk is not practicable for cheesemaking as it is for buttermaking. The high temperature seems to bring about a change in the solubility of the lime salts. The addition of a soluble lime salt to the pasteurized milk restores the normal condition towards the action of rennet, but the curd obtained does not ripen properly into cheese.

The most important qualification of a successful cheesemaker is ability to control and regulate the fermentation in the milk and curd, as fer-

mentation has most important and far-reaching effects upon the nature of the product. A certain degree of fermentation is essential in the milk before renneting, and in the curd before salting; indeed, success or failure in Cheddar cheesemaking is largely determined by the extent to which fermentation is allowed to proceed during the process of making. Fermentation in milk and curd is a chemical change induced by bacteria or their products. The first change, under normal conditions is conversion of part of the milk sugar into an acid, termed lactic acid, and is due to the activity of one or more species belonging to a group of micro-organisms known as lactic bacteria. The lactic acid produced gives an acid flavour to the milk, and will, if allowed to accumulate, coagulate it.

The first direct effect of acidity in Cheddar cheesemaking is to assist rennet action. In the absence of acidity the milk will not readily coagulate with rennet and thus produce a coagulum of the consistency necessary for successful cutting and cooking. Acidity is one of the agents necessary in the cooking of the curd. It causes the particles to contract and whey to be expelled. When acid is not sufficiently developed the curd is generally too soft and imperfectly cooked. Owing to excess of moisture, lactic acid is responsible also for the first change in the digesting or ripening of the curd. It induces a partial solution of the casein, which is indicated by the curd stringing or 'drawing' when applied to the hot iron as explained below, and by the close matting of the curd when piled in the cooler. Again, some degree of acidity is necessary for the digestive action of the pepsin ferment during the curing of the cheese, and the lactic acid in the curd supplies this want. The development of lactic acid in the ripening milk has a purifying effect, as the lactic bacteria, when in vigorous development in milk, hold the less desirable germs in check. It is common experience to find that, when the acidity is slow to develop, undesirable bacteria multiply rapidly in the milk and produce a bitter or other unpleasant flavour in the curd. Thus a certain degree of acidity in the curd is necessary for the best results in Cheddar cheesemaking, and this acidity may be stated as about 1 per cent of acid in the moisture contained in the curd when salted. If much less than this is present the curd does not ripen properly, but remains soft, and tough in texture, develops objectionable odours and flavours, and goes to form a cheese of very poor quality. On the other hand, too much acidity is equally injurious. It causes the texture to become short and crumbly, the flavour to become strong and acidy, and decreases the value of the cheese very considerably.

The primary cause of lactic fermentation is the development of bacteria, and the control of fermentation means the control of bacterial growth. The conditions of bacterial growth have been studied only comparatively recently, and fermentation in dairy products is now under better control. Bacteria require for their growth a temperature within certain limits, and for each species there is a minimum and maximum temperature below and above which no growth takes place. A second essential condition of growth, which concerns us here, is the presence of sufficient moisture in the medium. Most species attain the most rapid development only when there is about 90 per cent of water present in the substance. In practical cheesemaking, bacterial action is controlled chiefly by taking advantage of these two essential conditions: (1) by regulating the temperature, (2) by regulating the proportion of water in the medium. The most rapid development of acidity in milk and curd takes place at about 95° F. There is little growth of lactic bacteria under 60° F. or over 140° F. So that cooling the milk to about 60° F., as soon as possible after it leaves the cow is one of the most effective methods of controlling the acidity. It may be mentioned here that while 95° F. is the optimum temperature for lactic bacteria, it is not the temperature at which the greatest relative growth of that species takes place in the milk. At that temperature there are encouraged gas-producing bacteria, which are able to supersede the normal lactic germs. The greatest relative growth of lactic bacteria in milk takes place at about 70° F.; and it should be the aim of every cheesemaker to reduce the temperature of the evening's milk to below 80° F. as quickly as possible. Much trouble in cheesemaking is due to neglect of this simple rule. In some cases the evening's milk is allowed to remain at a temperature of 80° F. or over for several hours after milking, and a bacterial disease of the milk sets in, such as the production of gas, the development of other unpleasant flavours, discoloration, or casein digesting fermentation, the cause of much of the old trouble of cheese not 'staning' or draining properly. In such cases blame is often laid upon the milk itself as being too rich, or upon the weather, or the particular farm or dairy, while the application of sufficient cold water to cool the evening's milk would probably prevent the trouble. There is another way in which temperature is used to control the fermentation in cheesemaking, *i.e.* by regulating the temperature of the curing room. Curing rooms for Cheddar ripening in this country are usually maintained as near as possible at 60° F., but for slower development a lower temperature may be adopted.

The effect of moisture on the development of acidity in curd is made use of at various stages of the process. The first important check to fermentation is after coagulation of the milk, when the serum or whey begins to separate out from the coagulum. The more the whey is removed from the curd the more the acid development is retarded. Thus the time of renneting the milk has a great influence on the subsequent development of acidity in the curd. All experienced cheesemakers are aware that renneting too early gives a 'slow' cheese, and too late a 'fast' cheese. The ripening of a cheese is influenced by the cooking or drying of the curd. A curd which is too dry will ripen slowly and perhaps imperfectly, while a soft curd will ripen more rapidly. And for the same reason makers have to be careful in the making of the softer

varieties of cheeses, such as Dunlop, or English Cheddars, to allow less acidity before renneting and before removing the whey.

The most rapid development of acidity in cheesemaking takes place in the milk before coagulation. After coagulation the fermentation is considerably checked owing to removal of moisture from the medium. Early renneting of the milk and early cooking of the curd tend to retard ripening, and vice versa. The cooling of the evening's milk, the adding of the starter, and the renneting of the milk all afford opportunities of controlling the acidity. After renneting, attention is given specially to the acidity at the time of drawing off the whey, and the maker's previous experience will be specially useful at this stage. It is in drawing off the whey when exactly the proper stage of fermentation has been reached that much of the success in cheesemaking lies. If the whey is run off too early, all the defects due to insufficient acidity will become evident in the cheese; and if removed only after fermentation has proceeded too far, all the evils accompanying over-acidity will be found. The fine point in quality is often to be attained by nice adjustment of the acidity in the curd at the time of drawing the whey.

Other factors influencing the maturing of the cheese are the condition of the cured when salted and the pressing of the curd; but if the rennet has been added to the milk, and the whey removed from the curd at the proper time, salting is a comparatively simple matter, even to the inexperienced. The curd may be salted in about two and a half hours after drawing the whey. The salt added has some effect in checking bacterial action, and the more salt applied the slower the ripening; but, as we shall find later, salt has another and more important function in cheesemaking.

Besides being able to control the fermentation in the milk and curd, the maker must be able to determine the degree of acidity present. The acidimeter is often used for this purpose. In testing acidity in curd by the acidimeter the curd is pressed in the hands to expel the whey, and the acidity in the whey ascertained. Unfortunately the testing of milk for renneting is not so simple, as it is not the total acidity that has to be considered, but the percentage of lactic acid only, and the acidity in milk is often partly due to the presence of carbon dioxide, an acid gas which is dissolved in the milk, and is subsequently expelled by the heating of the whey. The percentage of carbon dioxide in the milk at this stage is relatively large, and is variable, and experience has proved the acidimeter to be quite unreliable as indication of the subsequent development of acidity in the curd. The most reliable test for this purpose is the rennet test. It is based on the principle that the time of coagulation is proportional to the acidity in the milk, other conditions being equal. In practice the accuracy of the results depends upon having the other conditions as nearly equal as possible. Four ounces of milk are carefully measured from the vat into a small cup, and brought to exactly 84° F. Exactly 1 dr. of rennet extract, of uniform and known strength, is added, and the number of seconds that elapse before coagulation becomes evident carefully noted. The observations as to the first signs of coagulation may be made by inserting and removing the finger every second, or by causing the renneted milk to drip through a small opening in the bottom of the vessel. In the latter case the dripping ceases when coagulation reaches a certain point. If great care is observed as to measurements and thermometer readings useful results are obtained, but in inexperienced or careless hands the test may be entirely misleading. It is a comparative test only, and no definite figure for acidity at time of renneting can be given. This must be determined by each maker for his own particular case, from his own experience in the given dairy, and with milk from the same source. The rennet test is useful only for comparing the acidity in the milk with that earlier or later, or with the acidity in the milk of the previous day. Useful information as to time for renneting can always be obtained by considering the previous treatment of the milk, such as the rate of cooling, the temperature overnight and in the morning, the percentage of starter added, and the time of ripening.

Probably the simplest and most reliable test for acidity in the curd before running the whey, milling, or salting, is what is known as the 'hot-iron test'. A small piece of curd is applied to a hot iron, just warm enough to roast it without charring. When applied lightly and removed very gradually, the curd forms fine silky threads stretching out from the iron. Acidity has the effect of partially digesting the curd, so that it will 'draw' out in fine threads in this way, and the length and fineness of the threads before fracture takes place are reliable indications of the degree of acidity in the curd. Within limits, the longer and finer the threads the greater the acidity, but when a certain degree of acidity has been attained—usually about 1 per cent—the curd does not form threads at all, but simply melts on the iron. When fine threads about a quarter of an inch in length are obtained, the whey may in general be removed immediately; but here again no fixed rule for acidity can be laid down, as the length of thread for the best results will vary considerably in different cases, and can be arrived at only by experience in a given dairy.

We have attempted to impress upon the reader the importance of controlling and measuring the degree of fermentation in the milk and curd, but equally important is the *nature* of the fermentation taking place. The fermentation must be cultivated both quantitatively and qualitatively. The bacterial changes desired primarily in Cheddar cheesemaking are such as will produce lactic acid; but milk offers such favourable conditions for the rapid growth of many different species of bacteria, which, under ordinary conditions in practice, readily gain access to it in large numbers from the surroundings generally, that it is often a matter of chance as to which species will ultimately predominate and give its special characteristic

feature to the cheese. When strict cleanliness is not observed, the impurities introduced into the milk are certain to affect prejudicially the quality of the cheese. Common defects from this cause are gasiness and bitterness, due to the presence and growth of species of bacteria which abound in the animal excrements and in dusty fodder, and the presence of which points directly to want of care in handling the milk.

The methods of ripening the milk for Cheddar cheesemaking may be divided into three distinct classes: (1) natural ripening, which is controlled chiefly by the temperature; (2) by the addition of some kind of home-made starter, such as sour whey, buttermilk, or milk soured naturally; (3) by the use of culture or commercial starters.

One of the earliest methods of procuring acidity in the milk was to add a 'starter' consisting of sour whey held over from the previous day. In the light of the knowledge of the present day it will be quite evident that this sour whey starter would have a predominating influence on the character of the product, and this was the common experience at the time. In many cases the whey starter had acquired a strong, objectionable flavour, which it transmitted to the cheese manufactured by its use. Many of the shrewder makers were in the habit of occasionally securing whey starters from neighbouring farms where the cheeses were at the time turning out more satisfactorily. Other forms of starters sometimes used were sour cream, buttermilk, and milk which had been allowed to sour naturally. Such home-made starters were necessarily more or less impure, in many cases containing some species of bacteria which gave rise to undesirable fermentations in the ripening milk, or in the curd during curing.

The use of culture starters is now fast becoming universal, and has resulted in a great and progressive improvement in the quality of the product. This has largely been brought about through the influence of the Dairy Schools and chiefly of the Scottish Dairy Institute, now the Dairy School for Scotland and incorporated with the West of Scotland Agricultural College, which was established at Kilmarnock in 1889.

In the earlier years of its existence the method of ripening the milk by the use of sour whey was superseded by that of developing the necessary acidity naturally in the milk by regulating the temperature, *i.e.* by keeping the evening's milk overnight at a temperature which would develop the degree of acidity required. It was generally found that sufficient acidity was developed, without the addition of any starter, when the evening's milk was at a temperature of from 66° to 70° F. in the morning. This method of ripening the milk was very generally adopted, and was the means of producing many cheeses of fine quality. There was associated with the system, however, some uncertainty as to the nature and extent of the fermentation in the milk overnight, and since the application of pure culture starters to cheesemaking, better and more uniform results have been obtained from their use than from any of the earlier methods of ripening the milk.

The principles of pure culture ripening are: (1) the elimination, as far as possible, of the bacteria usually present in the milk; (2) the inoculation of the milk with a large number of the desirable germs, to 'start' the proper fermentation and control the ripening. The introduction of pure-culture ripening was brought about under rather interesting circumstances. A common and very serious defect in Cheddar cheese in the south-west of Scotland at that time was a form of discoloration. The colour of the cheese became bleached in large patches, and an unpleasant flavour became pronounced in the affected parts. A discoloration committee was formed at Castle Douglas in September, 1895, with the object of discovering the cause and a remedy, and of improving the cheese of the south-west of Scotland. The committee was composed of several of the leading dairy farmers, practical cheesemakers, and dairy instructors, including Mr. R. J. Drummond of the Kilmarnock Dairy School, while Mr. J. R. Campbell, B.Sc., of the Glasgow Technical College, was employed to make observations on the scientific part of the work. As the result of the committee's investigations it was concluded that discoloration was probably caused by a species of bacterium which developed in the ripening milk overnight and in the curd; that the keeping of the evening's milk at a temperature lower than that commonly adopted would tend to check the development of these bacteria in the milk; that the addition of a starter, such as the pure culture starter used in the ripening of cream for buttermaking, to the mixed milk in the morning would tend to bring about a desirable ripening in the milk and curd, and to further check the development of the injurious bacteria causing the dreaded discoloration. These theories were put to the practical test by the committee, and were fully confirmed by the results obtained in extensive experiments in cheesemaking at various centres in the counties of Ayr, Kirkcudbright, and Wigtown in 1896 and 1897. These findings were further confirmed by the results of extensive bacteriological examinations of samples of discoloured cheese, and of other detailed bacteriological investigations. The use of culture starters in cheesemaking was quickly adopted by many of the leading makers, and has of late years been greatly extended through the influence of dairy schools and itinerant instructors in the south-western counties of Scotland and in England generally, with the result that the quality of the cheese is more uniform than formerly, and of a higher standard of merit, due largely to the more regular control of the ripening processes.

Next in importance after fermentation comes the cooking of the curd. This is a process of draining away much of the moisture contained in the curd at time of coagulation. In Cheddar cheesemaking, the serum or whey is gradually expelled by various agencies, until the moisture is reduced from about 87 to about 33 per cent. The cooking of the curd largely determines the texture and body of the cheese, and also its keeping properties. The chief condition for the removal of moisture, after coagulation of the milk,

is contraction of the curd, and this is brought about for the most part by heat and acidity, also by mechanical pressure, and to a certain extent by salt. The cutting of the curd into fine particles facilitates cooking by exposing a greater surface. Heat and acidity cause the curd to contract, and, within limits, the higher the temperature and the greater the acidity the drier the curd will become. The temperature of cooking or scalding for Cheddar cheese varies very considerably according to the season of the year, the quality of the milk, the food of the cow, &c., but in general it ranges from about 94° to 104° F. Heat alone or acidity alone will not properly cook the curd. The combined action of the two agents is necessary. Another important condition for the cooking of the curd is sufficient time for the contraction, due to heat and acidity, to take place. The aim of an intelligent maker will be to so regulate the fermentation and draining processes going on in the curd relatively to each other, that both will reach a certain stage at the same time. This important point is reached at the time of drawing the whey, which should be in from three to three and a quarter hours after renneting. Then the curd should be just sufficiently dry, and the acidity in it just sufficiently developed, to give the finest quality in the product. If heating is accomplished too rapidly, a skin forms on the surface of the curd particles and interferes with the proper draining of the whey. If the acidity develops too rapidly relatively to the cooking process, the curd is still insufficiently cooked when the whey has to be drawn off, and the cheese will be too soft from excess of moisture. On the other hand, if the acidity is slow to develop, the curd becomes too dry by the time sufficient acidity is obtained.

It will be observed that the points in cheesemaking of paramount importance are: (1) to secure a pure fermentation in the milk and curd by the presence as far as possible of only the desired species of bacteria; (2) to regulate the fermentative and drying processes, relatively and absolutely, to exactly that degree which is found from experience to give the best results.

We will now describe some of the practical details of the process of Cheddar cheesemaking as taught in our dairy schools and practised by the leading makers in this country. The evening's and morning's milk is collected and mixed together in the same vat. The treatment of the evening's milk is one of the points carefully attended to. The object is to keep the milk as free as possible from all bacterial growth until it can be inoculated, along with the morning's milk, with the true 'cheese germs' contained in the culture starter. Previous to milking, care is taken to have the air of the byre as free as possible from dust and germs. The cows are prepared for milking by having the udders cleaned with lukewarm water and a cloth. The hands of the milkers are washed in clean water immediately before milking each cow. The first milk drawn from each teat is put aside, not to be used for cheesemaking. This milk is of very poor quality, and is usually contaminated with large numbers of germs capable of causing serious trouble in making. Milking with dripping hands is avoided as far as possible, as introducing into the milk liquid filth which cannot be subsequently removed. The milk is drawn from the cows as quickly and thoroughly as possible, immediately strained, and removed to the purer atmosphere of the dairy. Here it receives a second and more effective straining through three or four layers of straining cloth previously sterilized by boiling. The milk is strained directly into the vat in which it is cooled and kept overnight. Cooling is effected by causing cold water to circulate between the casings of the vat, and by regularly but gently stirring the milk. The temperature of the milk is reduced in this way to near 70° F. as soon as possible after it is drawn from the cow. Cooling the evening's milk in the vat is preferable to the practice, once common, of setting the milk in earthenware coolers or shallow pans. The temperature of the evening's milk next morning is usually from 62° to 67° F., but the higher temperature is admissible only if the milk has been rapidly cooled the previous evening.

In the morning the first duty is to note the temperature of the milk, and to incorporate with the milk any cream which may have risen to the surface overnight. This is effected by pouring the cream through the strainer along with the warm morning's milk. The starter is measured out, added in the same way as the cream, and well mixed with the milk. As already explained, great care has to be exercised in determining the quantity of starter to be added on each particular day, and the temperature of the evening's milk in the morning is always to be taken into consideration in this connection. That quantity is added which will ripen the milk, ready for renneting, in from a half to one hour after all the milk has been collected in the vat, and so that the time from renneting the milk to salting the curd will be from five and a half to six hours. Too much starter will cause too rapid development of acidity. Generally the quantity used is from $\frac{1}{4}$ to $\frac{3}{4}$ per cent, but in some cases much less is found to give better results. After the starter is added, heat is applied, and the morning's milk added as received. The whole is brought to a temperature of 84° or 85° F., and allowed to ripen until sufficiently acid for renneting.

As soon as all the milk has been received into the vat, a colouring substance (annatto) is mixed with the milk. About 2 oz. is usually sufficient to colour 100 gal. of milk, but more or less is used according to the intensity of colour desired. To facilitate rapid and thorough incorporation with the milk, the colouring is diluted with about six times its bulk of water before it is added to, and stirred with, the contents of the vat.

The time for adding the rennet is determined by one or other, or both, of the tests already referred to. The milk may be said to be ready for renneting when there is reason to believe that, with that particular degree of acidity, the subsequent fermentation will proceed at the proper rate relatively to the cooking processes

going on in the curd. Sufficient rennet is added to coagulate the milk to the proper consistency for cutting in forty or forty-five minutes at a temperature of 85° F. This usually requires about 4 oz. per 100 gal. of milk, slightly less in spring and more in autumn. The rennet is diluted with pure cold water and stirred with the milk for from three to five minutes, care being taken to give a uniform distribution of the ferment and yet to leave the milk entirely at rest before coagulation becomes evident.

When curd has formed of the proper consistency it is cut into small uniform cubes by using first a perpendicular then a horizontal curd knife. On cutting, whey begins to separate out, and stirring of the curd and whey has to be kept up continuously for about one and a half hour during the cooking of the curd, to prevent the soft particles of curd from sticking together or matting in the bottom of the vat. The stirring is done first by hand, and when the curd has become a little firmer, by a special wooden rake. About ten minutes after cutting, heat is applied very gradually to the vat, and the temperature of the contents increased about 1° F. every four or five minutes, until the cooking or scalding temperature is reached in about sixty minutes after cutting. Stirring is continued for about twenty or thirty minutes after heating, or until the curd is sufficiently firm to settle in the bottom of the vat without matting.

The curd is allowed to lie under the whey, cooking and developing acidity, until the stage is reached at which the whey should be run off. This is usually in about one hour after settling, or three and a quarter hours after renneting. Drawing the whey has the effect of determining the cooking of the curd and controlling the subsequent fermentation, and unless both are properly regulated there will be an imperfect product. The maker must be guided at this point chiefly by the acidity, but a skilful maker will have been watching closely the rate at which the acid has been developing, and hurrying or holding back the cooking process accordingly. The acidity in the curd is determined by the tests already described, usually by the hot-iron test. In deciding upon the degree of acidity to be developed in the curd at this stage, the maker must be guided by his or her own previous experience. A good rule is to observe the time that elapses after drawing the whey, before the curd is sufficiently matured for salting. If there has been sound judgment as to the drawing of the whey, the curd will be ready for salting in from two and a half to three hours. If a shorter time is required, the fermentation has been too far advanced before the whey was drawn, and vice versa, and the maker should remember the fact for his or her guidance on the following day. The consistency of the curd is also an indication for an experienced maker. If the acidity is sufficiently developed the curd will be somewhat firmer to the touch and more perfectly cooked than earlier in the process.

When the whey has been allowed to run off, so as to expose the surface of the curd, the latter is removed to the cooler and stirred for a few minutes over draining racks covered with a draining cloth, to remove excess of moisture. The manner of draining at this stage influences the nature of the product considerably. Slower draining, with the retention of more moisture, leads to a quicker development of acidity and a softer curd. If the method of slow draining is followed, the whey must be removed from the curd decidedly sweeter. When the curd is sufficiently dry it is piled up at one end of the cooler to a depth of about 6 in. to retain the necessary moisture and warmth and undergo further fermentation. It is covered with cloths to keep the surface warm and the fermentation uniform. In half an hour it is cut into pieces about 10 in. square and turned. It is subsequently turned and piled up double every half hour until it is milled. The curd is milled when it has changed from the loose granular state to a compact, smooth, and tough condition, and will readily draw on the hot iron in threads about 1½ in. long. It is usually milled in about one and three-quarter hour after being removed from the vat. Milling implies passing the curd in pieces through a disintegrating machine or curd mill. The object is to reduce the curd to small fragments, of a size that will afford equal distribution of the salt, and facilitate removal of moisture and close packing of the curd during pressing.

After being broken, the curd is stirred by hand for about fifteen minutes to liberate the accumulated gases and admit of aeration. It is subsequently piled and covered up to further mature before being salted. At this stage a ripe, creamy flavour is developed, and the curd mellows so that when pressed in the hand it gives out about equal parts of whey and liquid fat. The curd will not now draw on the hot iron, but simply melts down with the heat; and the liquid expelled on pressing the curd, when tested by the acidimeter, will show about 1 per cent of acid. A careful maker will not salt the curd too early, but will wait until, in his opinion, the curd has properly matured, and thus avoid that openness and toughness in texture and bitterness in flavour not infrequently found in Cheddar cheese.

Salt is added chiefly for the flavour it imparts to the cheese. Curd ripened without salt acquires a strongly bitter flavour. Salt, if present, neutralizes the bitter principles produced in the curd during ripening. It also promotes the expulsion of whey, and has a certain preserving effect. The quantity used is governed to some extent by the moisture and acidity in the curd, and the time to be allowed for ripening. For Cheddars a common proportion used is 1 lb. of salt to 50 lb. of curd. The salt is thoroughly mixed with the curd by hand, and about fifteen or twenty minutes allowed for it to dissolve and diffuse into the curd particles before pressing. The curd is packed into the chesset at a temperature not below 76° F. At lower temperatures the particles do not cohere closely, and the whey is not properly expelled.

Pressure is applied very lightly at first, just sufficient to start the whey to run, and is gradu-

ally increased, so that by the end of three hours the total weight acting on the cheese is not less than 2 tons. Heavy pressure tends to give a close solid texture and body, and to remove the free moisture which would cause a sharp, bitter flavour in the cheese. Pressure is maintained constantly for three days, after which the 'green' cheese is sent to the curing room.

During pressing, attention is given to the finish and appearance of the cheese. The chesset or mould determines the form and size, and only chessets of a fashionable pattern, capable of containing from 80 to 90 lb. of curd, are used. Special measures are adopted to secure a thin, smooth rind and well-formed edges. The cheese is turned in the press the first evening, and receives a hot bath next morning by being immersed in water at 140° F. for one minute. It is turned in the press daily, and a fresh, dry cloth applied each time, until the third day, when the surface is liberally greased with pure lard and covered on the ends with thin cotton. Next morning it is removed finally from the press, and firmly and neatly bandaged with cotton to preserve the shape during curing, and leave a smooth surface, free from cloth marks or other impressions. A good finish always enhances the value of a cheese to a buyer quite appreciably.

Curing occupies about ten or twelve weeks according to conditions. The curing of hard cheese includes several complex changes, the study of which presents many difficult problems. Several theories of curing are held—that the important changes are due to bacteria, to lactic acid, to enzymes inherent in milk. These theories are shown to be inadequate to explain the circumstances of the case. Later researches (Coward) go to show that the agent chiefly responsible is the small proportion of pepsin contained in extract of rennet; that the action is dependent upon the presence of a sufficient degree of acidity in the curd, that the acidity is supplied in practice by the development of lactic acid in the process of cheesemaking. Certainly, in practice, the degree of acidity developed is found to have a predominating influence on the subsequent changes in the curd, and the character of the ripened product.

The time necessary for curing depends upon several conditions, such as the acidity of the curd, the percentage of moisture, the quantity of salt, the quantity of rennet, and the temperature of the curing room. Within limits, the higher the temperature the more rapidly the changes take place. Difference of opinion exists as to the best temperature for curing. Some advocate curing at lower temperatures, such as 40° to 50° F., as is commonly done in warmer climates. Low temperatures of curing may be advisable when dealing with relatively impure milk which has been exposed to sources of contamination over which the maker has little or no control. It is during the comparatively slow changes in the curing room that undesirable germs present make themselves evident, and a low temperature of curing tends to inhibit their development. There is less evaporation of moisture and loss of weight at the lower temperature, but unless the curd is more thoroughly dried in the making to counteract this effect, the cheese will come out too soft and weak in character. Curing at low temperatures implies longer time and slower returns, while the expense of artificial cooling is very considerable. Experience shows that when dealing with comparatively pure milk, under favourable conditions, the best results are obtained by curing at about 58° or 62° F. The best cheeses produced in this country, and admitted to be the finest in any country, are invariably cured at, as near as practicable, the higher temperatures. See also CHEESE, STATISTICS OF, and succeeding articles. [W. ST.]

Cheese. — Cheese is the name given to various preparations of the casein of milk, separated, together with some of the other constituents, by means of rennet, and afterwards rendered more soluble and digestible by the action of ferments; the action of these being encouraged by the processes employed in making and in the subsequent treatment. These ferments which act on the insoluble casein are of the unorganized type called *enzymes*, though they may owe their origin in part to the organized bacteria or moulds which develop in the cheese. They are also in part derived from the enzymes of the rennet and from the natural enzymes present in the milk. The exact part which all these enzymes play in the ripening is not at present known, and differs in different cheeses, some having been investigated more than others.

Very many varieties of cheese are made in different parts of the world, some being made from the milk of different animals, many from the whole milk of the cow, while others are made from skim milk, and others again from cream or very rich milk. Different districts have their special varieties of cheese, but these varieties are dependent more on the manner of making than on any differences in the soil and herbage. The methods employed result in cheeses varying from small 'soft cheeses' to large, hard, pressed cheeses.

The starting point is in all cases pure fresh milk. It is not possible to destroy undesirable ferments by pasteurization or sterilization, for milk so treated will not make a cheese which will ripen. It is therefore of the greatest importance that the milk should, to begin with, be as free as possible from organisms which might produce injurious results. Among these are bacteria of the type of *coli commune*, which produce 'heaving' in the cheese—small holes caused by the production of gas. There are several germs which produce this effect, and they are for the most part derived either from cow manure or other fæcal matter direct, or through the medium of contaminated water which may have got on the cow's udder when the cows are allowed to stand in dirty ponds, &c. The remedy, as in all cases of microbic contamination, is cleanliness: the washing of the udder of the cow, the hands of the milker, and the milking vessels with a suitable disinfectant solution. Among the other numerous organisms which may be present in the milk are a number which result in the production of various taints in the cheese. Of these taints bitterness is one,

and is sometimes caused by bacteria, as in the case of *Micrococcus casei amari* and *Tyrothrix geniculatus*, organisms which produce peptic ferments.

An interesting example of a bitter cheese organism is that of *Torula amara*, the source of which was traced to the leaves of the sugar maple, under which the clean churns were placed and became infected—a practice which resulted in much cheese being spoiled in Canada before the source of infection was found out. Black spots in cheese may be caused by moulds; or by particles of iron which get into the milk and are afterwards changed to sulphide by sulphuretted hydrogen produced in ripening. Other moulds which produce colours in cheese may get into the milk or may be derived from the air or utensils of the dairy at later stages in the manufacture.

Although it is important that these injurious organisms should be absent from milk which is to be used for cheesemaking, it is equally important that a proper degree of acidity should be developed in the milk, and in the case of some cheeses this is brought about by the addition of a pure culture of a lactic ferment which goes by the name of 'starter'. Freudenreich and others have claimed that these lactic ferments play a very important part in the subsequent ripening of the cheese; but it is probable that their chief function is the production of lactic acid, which has a very great influence on the nature of the curd subsequently produced. Some bacteriologists have thought that the casein ferments of the Tyrothrix type discovered by Duclaux were of importance in cheese ripening; and on the Continent cultures of these bacteria have even been used for cheese-making, but the results have not justified their use.

The pure milk having attained a suitable degree of acidity, is coagulated with rennet, the rennet ferment converting the caseinogen of the milk into casein, the calcium salt of which is insoluble. The process of coagulation takes place in two stages. The first stage is a fermentative change, dependent solely on the rennet ferment, whereby the caseinogen is converted into casein. The second stage is dependent on the presence of lime salts, and consists in the curdling of the milk or the separation of the insoluble calcium caseinate. With this curd most of the fat is also carried down, together with some of the other constituents and the proteolytic ferments of the rennet. The temperature, salting, pressing, and other subsequent treatment will determine the nature of the ferments, which carry on the further ripening processes; but in all cases the casein is broken down to more soluble bodies, such as leucine, tyrosine, and even ammonia. Bodies allied to peptones are probably of the greatest importance.

The analysis of cheese includes the determination of the water, fat, total nitrogen, ash, and salt. The products of ripening are also sometimes determined, and the fat is examined, as in the case of butter fat, for animal fats.

The water, ash, and salt are determined by Richmond's method in 2 or 3 grm. of cheese, which are cut into small pieces in a flat-bottomed dish and dried in the water oven for six hours; the basin is inclined so that the fat runs off the drying cheese. Weighings are then made at intervals of one hour till the result is practically constant. The loss in weight gives the water in the portion taken. The melted fat is then poured off, and the residue macerated in hot amyl alcohol; when this has been drained off, the residue is burnt and the ash is weighed. The salt is then dissolved out, and the chlorine titrated with one-tenth normal silver nitrate; the number of c.c. used multiplied by 0·00585 gives the grm. of salt in the weight taken.

The fat may be extracted with ether in a Soxhlet extractor, after first grinding up 3 or 4 grm. of the cheese in a small mortar with twice the weight of anhydrous copper sulphate. Modifications of the Werner-Schmid method and Göttlieb Rose method are also good. The total nitrogen is determined by Kjeldahl's method in about 1 grm. of cheese.

According to Richmond, the products of ripening may be estimated in the following manner: Weigh 10 grm. of cheese, place in a small mortar, and add 25 c.c. of boiling water; with a pestle grind up the cheese and water, and pour off the solution through a filter, collecting the filtrate in a 250 c.c. flask; repeat the treatment with 25 c.c. of boiling water till nine portions have been used; cool the total filtrates, make up to 250 c.c., and mix well. Evaporate 50 c.c. in a weighed basin, and weigh the solids after drying till constant; ignite and weigh the ash; the weight of the solids less the ash represents the products of ripening. The difference between 100, and the sum of the water, fat, ash, and products of ripening, may be taken as unaltered casein.

The products of ripening may be differentiated; to 50 c.c. of the filtrate add 5 c.c. of copper sulphate, and estimate the primary products of ripening by the Ritthausen method as follows: Neutralize with caustic soda solution; collect the precipitate in a weighed Gooch crucible, wash well, and dry in a water oven; extract the fat with ether, and dry till constant. Ignite and subtract the weight of the ash, the difference will give the weight of the primary products of ripening, *i.e.* soluble proteins.

To examine the fat, about 50 grm. are dried till the fat runs out; the remaining curd is then extracted with ether, and the ether evaporated from the fat; the fat is then examined as in the case of butter fat (see BUTTER), the Reichert-Wollny figure being generally determined. The addition of animal fats can be thus detected. The removal of fat from the milk used in making the cheese can be assumed if the fat is less than 45 per cent of the dried cheese, or less than six times the total nitrogen.

Certain tests are of considerable value in cheesemaking, in addition to the estimation of fat and curd in the milk to be used. The absence of organisms causing heaving can be ascertained by a fermentation test, which consists in placing about 10 c.c. of the milk in a sterile test tube and keeping it at blood heat for eighteen hours, during which time no bubbles of gas

should be seen in the tube; milk which produces bubbles of gas in eighteen hours is likely to make 'heaving cheeses' (see above).

The acidity of the milk should be determined by titration with standard caustic soda solution, phenolphthalein being used as an indicator (see ACIDIMETER). The knowledge of the right acidity to be developed for a particular cheese in a particular district before adding the rennet is most important; other operations can also be regulated by the acidity of the whey. The titration is generally made in a small white porcelain dish, 10 c.c. being taken and a few drops of the indicator. If $\frac{N}{10}$ caustic soda (free from carbonates) is used, each $\frac{1}{10}$ c.c. represents 1° acidity, and the degrees multiplied by 0·009 will give the acidity in percentage of lactic acid. The strength of the rennet is also determined (see RENNET).

The composition and fermentation changes which take place in cheese differ according to the various methods employed in their manufacture; a few of the principal types of cheese will therefore be taken in order.

Cream cheese may be made without the use of rennet, the lactic acid ferments being used to thicken the cream. According to Vieth, such a cheese contains water 30·66 per cent, fat 62·99 per cent, proteins 4·94 per cent, lactic acid 0·26 per cent, and ash 1·15 per cent. The variations are considerable according to the methods used.

In the case of soft cheeses of the Camembert type the enzymes producing ripening and partial liquefaction of the casein come from moulds which grow on the surface of the cheese, the mats on which the cheeses are ripened often producing the necessary infection; but on starting to make the cheese in a new district it is necessary to introduce the right organisms. *Penicillium candidum* plays an important part, and *Oïdium lactis* is also found on these cheeses in the earlier stages. The composition of Camembert as given by Duclaux is as follows: Water 45·24 per cent, fat 30·31 per cent, proteins 19·75 per cent, ash 4·70 per cent.

Intermediate between the soft and hard pressed cheeses comes the moulded Stilton, with its drab-coloured, wrinkled skin. The milk is often enriched with cream for the manufacture of this cheese. The method of making the cheese admits of the growth of green veins of *Penicillium glaucum*, a mould which develops at later stages of ripening and consumes the acid produced by the lactic ferments, and favouring the further ripening of the cheese. Other cheeses, the Roquefort (made from sheep's milk), Gorgonzola, &c., depend to some extent on the growth of this mould. The composition of Stilton as given by Voelcker is as follows: Water 32·18 per cent, fat 37·36 per cent, proteins 24·31 per cent, sugar and extractives 2·22 per cent, salt 0·89 per cent, ash 3·04 per cent.

The following table gives typical analyses of some of the principal hard-pressed English cheeses:—

	Cheddar.	Derby.	Leicester.	Gloucester Single.	Gloucester Double.	Cheshire.
	per cent	per cent	per cent	per cent	per cent	per cent
Water	33·92	35·00	34·05	27·66	33·78	35·15
Fat	33·15	28·00	28·28	27·12	27·19	29·38
Casein	28·12	29·00	28·50	38·00	31·50	25·38
Sugar and extractives ...	0·96	4·00	4·98	3·05	3·21	5·77
Salt	1·15	1·15	1·12	1·26	1·55	1·75
Ash	2·70	2·85	3·07	2·91	2·77	2·57
	100·00	100·00	100·00	100·00	100·00	100·00

[J. Go.]

Cheese, Classification of.—The predominant types of English cheese belong to what is technically called 'hard' cheese, and the quantity of 'soft' cheese made in this country is relatively very small. In England there are more than half a score distinctive 'makes' of hard cheese, to wit: Cheddar, Cheshire, Cotherstone, Derbyshire, Dorset ('blue-veiny'), 'Factory', Gloucestershire, Lancashire, Leicestershire, Stilton, Wiltshire 'truckles', besides which there are several sub-varieties, such as Caraway cheese, Green cheese, and Buttermilk cheese, which are essentially sporadic and scarce, inasmuch as the demand for them is small and fitful. The Anglo-Saxon race all over the world run on hard cheese so generally and almost exclusively that the preference for it may almost be regarded as a racial question. Scotland and Wales have, each of them, a cheese of its own, recognized as such, viz. the Dunlop and the Caerphilly respectively. Caerphilly is a skim-milk cheese, and therefore of no serious account, even in Wales, which to a small extent produces it. It is one of Ireland's misfortunes never to have evolved a cheese of her own, for it is obvious that no herbage and climate elsewhere are superior to those of Ireland for—on modern lines—the production of cheese equal to the best made in England. Ireland is essentially a milk-producing country, but the genius of Irish dairyers has 'gone-in', almost wholly and entirely, for butter, than which no land can produce finer.

The soft cheeses of England that have more than a local habitation and a name are three in number, viz. Bath, Cream, and Slipcote. There are, however, many other makes or varieties, purely local and limited, and made pretty much all alike. Cream cheese is the only one that has any extensive importance, for it is known to everybody, and the others are not.

On the continent of Europe, especially in

France and Germany, soft cheese is predominant, and hard cheese is, broadly speaking, quite subordinate. All the same, however, there are several grand types of hard cheese, the king of which is the Emmenthaler of Switzerland, incorrectly known as Gruyère for the most part in this country. Italy is proud of her three hard cheeses—Parmesan, Gorgonzola, and Caccio Cavallo, the two former being famous in many lands. France, too, has her unique and popular Roquefort cheese, made for the most part from the milk of sheep and goats, especially of the former.

The number and variety of Continental soft cheeses are legion. Many of them are widely known, and at the head of these in popularity may be placed the Camembert. These are pleasant variations in a *menu*, but they are all relishes rather than serious articles of food. Others there are, mostly in Germany, which require that one's taste should be born to them, or that it should subsequently go through a long, an intricate, and a not altogether pleasant training. Soft cheeses cannot be regarded as economical foods as compared with hard cheeses, because there is much waste of crust about them, and most of them soon go off flavour. [J. P. S.]

Cheese, Statistics of.—No official estimate exists as to the quantity of cheese annually manufactured in the United Kingdom, although the subject has been occasionally dealt with by individual enquirers into questions of agricultural economics. Reviewing these various conclusions, but basing their own estimates largely on the relative consumption of cheese by various classes of the community, a recent Committee of the Royal Statistical Society, in reports explained to that body by Mr. R. H. Rew, suggests 10½ lb. per annum as the probable ration of cheese consumed by each unit of the population in this country at the present time. Two-thirds of this, it is clear from our import records, which form the sole reliable factor in the calculation, come from abroad, whence for some time we have been receiving a yearly quota of just 6·8 lb. of cheese per person. Not very much more than half as much, or 3·7 lb. per head apparently, therefore, represents the present domestic manufacture of this commodity. It would take less than 9 per cent of the milk furnished annually by the cows of the United Kingdom to supply this quantity. Practically 153,000,000 gal. of milk out of 1,723,000,000 gal. available for all purposes may thus be taken as supplying 1,366,000 cwt. of all forms of British cheese. The imports for the same group of years gave us nearly twice as large a figure, or a net total of 2,520,000 cwt. For the year 1907 this importation was indeed somewhat reduced, but taking a longer survey it may be said that over the whole period from the end of 1895 up to 1907 the receipts of cheese from abroad have kept very closely to an average of 2,500,000 cwt., a calculated ration of nearly 6·8 lb. per head having been thus maintained without much variation for a dozen years. The cheese imports of the United Kingdom have not increased with the same rapidity that has distinguished those of butter, but if the comparison be made with the period before 1870, when the total was below a million cwt., or with the five years 1871–5, when it averaged only 1,350,000 cwt., the addition is nevertheless considerable — the sea-borne supply being nearly doubled.

Unlike some other forms of imported food, the cheese which arrives in our ports in this country is, as to three-fourths of its bulk, the produce of a single British colony — Canada, whence in the last five years we have been accustomed to draw annually quantities varying from 1,700,000 to 1,900,000 cwt.—larger totals than our entire British production of cheese supplies. This source of imports has grown, while the quota furnished by the United States has of late steadily declined, reaching only 5 per cent of the total receipts in 1907. Holland with 242,000 cwt. of cheese, and New Zealand with 192,000 cwt., are the only other important contributors to our wants—the French and Belgian exports of cheese to this country collectively do not reach 120,000 cwt. in recent years.

The available statistics of the prices of cheese are not very satisfactory, but the published average of the Board of Agriculture 'Market Prices' for 1906 gave a mean of 73*s.* per cwt. for British Cheddar, and 71*s.* for Cheshire of first quality, while the average for Canadian Cheddar, which formed the bulk of the imports, was from 61*s.* in the lower to 63*s.* in the higher grade. For the whole year 1907 the Board of Agriculture figures quote British Cheddar as reaching a price of 76*s.* per cwt., but Canadian cheese prices remain as before, although for these the trade circulars of one of the firms engaged in the import trade, the figures for the year ended 30th June, 1907, run higher than this, or an average of 64*s.* 1*d.* for Canadian Cheddar compared with only 54*s.* per cwt. in the similarly collected prices for the whole ten years 1898–1907. The more general average values to be obtained from the Customs records of all grades of imported cheese over the two years 1906–7 stand at 58*s.* per cwt., while a price of less than 50*s.* per cwt. was ruling in the first five years of the century, and 45*s.* 8*d.* only in 1896–1900. To find an average of imported cheese values above 60*s.* a cwt. it would be needful to go back to 1866–70. [P. G. C.]

Cheese Fly. See PIOPHILA CASEI.

Cheese Knife. See CURD KNIFE.

Cheese Maggot, the larva of the Cheese Fly. See PIOPHILA CASEI.

Cheesemaking: Principles and Practice.—The origin of cheesemaking is lost in antiquity. It was, most likely, an instance of chance discovery; soured milk may have been left neglected in a skin until the liquid had drained away and the milk had shrunk into a semi-solid mass of curd. Fundamentally, the art and principle of cheesemaking lie in depriving the milk of some nine-tenths of its bulk and weight—this in the form of water, called 'whey' in the dairy. Milk is reduced and converted from a liquid into a solid state, and this expressly to checkmate its natural tendency toward decomposition. This secured, it may be

held over for leisurely eating at any time within one or two years, or longer, instead of one or two days. The art of cheesemaking secures the valuable constituents of milk in a portable and convenient form. Cheese, in point of fact, is condensed milk; or, rather, milk condensed in another way into a state that is at once more practical, and therefore more generally useful, than is its counterpart in sealed and soldered tins. Cheese and condensed milk differ but little in their constituents, for both contain all the valuable portion of the milk from which they were respectively obtained; yet they both differ materially from butter, because the latter contains, or should contain, no casein. The processes employed in the production of cheese, butter, and condensed milk are widely different, and a full account of the differences would form an interesting study in practical hygiene. Each of these substances has its own sphere of usefulness, those of the two first named being in a high degree important and extensive, whilst that of the last named is gradually extending but must always be comparatively small. The portability, the compactness, the simplicity, the preparedness, the excellence of cheese as food for man, and its long-keeping properties, constitute an array of merits which distances all rivalry.

Milk, as a liquid food for man, is unique and unapproachable, but it is unfortunately liable to early decay. Perhaps the most complex art within the wide range of agricultural industry, cheesemaking has been designed to relieve milk of this defect by placing nearly the whole of its valuable constituents in a state of preservation. The decay of milk may be postponed a little by keeping the milk at a low temperature, or by treating it with some suitable antiseptic, such as nitrate of potassium, commonly called nitre or saltpetre. The object in cheesemaking is to separate the solid and liquid portions of milk—the casein and the butter-fat on the one hand, and the whey on the other—and to preserve the solids by mixing with them about 2 per cent of chloride of sodium, commonly known as salt. The whey expelled carries off with it nearly all the milk sugar (lactose) which milk naturally contains; and as this milk sugar forms a congenial base for bacterial fermentation in milk, its expulsion removes the chief danger leading to early decay. This, however, is not enough; for as a small proportion of lactose avoids expulsion, and as casein itself is liable to change for the worse ere long, an antiseptic must be used to preserve cheese whilst it ripens, be that period one or two months or one or two years. Herein lies one of the complexities inseparable from cheesemaking, but not unconquerable. Whilst unchecked fermentation quickly deteriorates milk, a controllable amount of it is necessary to the due and correct ripening of cheese. Unrestrained bacterial fermentation in milk is soon marked by disaster in that most complex and delicate of fluids; in cheese the sequel is the same, though much slower and much less complete.

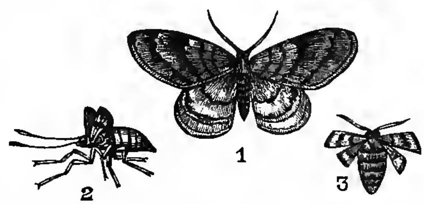
The art and practice of cheesemaking are therefore employed in concentrating the solids of milk into masses which, having been intelligently — in these days scientifically — manipulated, are in excellent form and condition for leisurely eating. Milk in its primary condition cannot be kept for this purpose; and even if it could, its bulk and weight and the vessels necessary to keep it in bounds are all inimical to its convenient portability and use. Cheese, therefore, is milk in a solid form, and minus its great preponderance of water. Cheese is milk in a state which lends itself conveniently to consumption in various ways, and, as such, it forms—when well made and perfectly ripened—the most convenient and economical article of food so far revealed to mankind. See CHEDDAR CHEESEMAKING. [J. P. S.]

Cheese Mite (*Acarus siro*), an arachnid which is very destructive, especially to the softer makes of cheese. See also MITES.

Cheese Press. See DAIRY APPLIANCES.

Cheese Rennet. See RENNET.

Cheimatobia brumata (the Winter Moth).—The caterpillars of this moth are one of the most destructive agents in orchards and gardens; practically all fruit tree and bush



Winter Moth (*Cheimatobia brumata*): Male and Wingless Females

fruit foliage is eaten by them, also the leafage of various forest trees and roses. The male moth is winged, greyish-brown, the fore wings with wavy, transverse darker lines, and is about an inch across; the female is almost wingless, there only being four small stumps for wings, the colour dusky-brown. The males appear somewhere about the first week in October, and fly at dusk along hedgerows and in woods and orchards; the females crawl out of the ground a few days later, and go on appearing until nearly Christmas. Being incapable of flight, the females crawl up the trunks of the trees and lay their eggs near the buds, in the axils of spurs and shoots, and also in crevices, where they remain until March; the eggs are spindle-shaped, but blunt at each end, deep-green in colour, becoming red when nearly ready to hatch, with distinct shell sculpturing. It has recently been found that the females may lay their ova on the trunks of trees and the young larvæ crawl up in the spring. The larvæ are at first grey, but become green with white lines. They are true 'Looper' or Geometer caterpillars, always progressing in a series of loops; they have six true legs in front, but only one pair of prolegs and an anal pair. Their food consists of the young buds, leaves, blossom, and even fruit. They spin the blossom trusses together and also the leaves, and thus they are sheltered; but early in life, and again before maturity, they are freely exposed. Length when

mature, about 1 in. They fall to the ground, usually in June and early July, and then enter the soil, where they spin a cocoon of silk, covered outside with grains of earth, and remain there until the moths escape in autumn and winter. Orchard and forest trees are frequently completely defoliated by them.

Treatment consists in 'grease-banding' the trees in early October to catch the wingless females, and continuing this treatment until nearly Christmas or later. If the grease-bands have to be placed high up owing to stock being kept in the orchards, they should be kept moist until the end of March to catch the larvæ from eggs laid below. Spraying with arsenical washes is also necessary, and should be done early in April or late in March. Either arsenate of lead or Paris green may be used. The former is best, as it does not burn the foliage as Paris green does. It is made as follows: (1) arsenate of soda (pure or crystalline), 3½ oz.; (2) acetate of lead, 7 oz.; (3) water, 10 gal. The arsenate and acetate are dissolved and then added to the water. Pigs and poultry are of much benefit, since they devour the caterpillars as they fall to the ground. [F. V. T.]

Cheiranthus. See WALLFLOWER.

Chelidonium. See CELANDINE.

Chelostoma florisomne is a wild bee, whose larvæ destroy hop poles and posts by burrowing in them. The bee is black: the male has a tuft of ochreous hairs on the face, and is downy; the body is semi-cylindric and incurved, with an oval tubercle on the belly, and four horny teeth at the tail; the edges of the five segments are fringed with pale hairs. The female has a larger head, shorter clubbed antennæ; the body is very hairy beneath, and the edges of the segments are white above. Length, 4½ and 5 lines. [J. C.]

Chemical Manures.—This term is sometimes applied to artificial manures. It has no very precise application, but is popularly applied to all such manures as are made by artificial chemical processes. Thus the dissolved manures, such as superphosphate and dissolved bones, which are made by acting on mineral phosphates and bones respectively with sulphuric acid, are looked on as typical chemical manures. Sulphate of ammonia, which is derived from the ammoniacal liquor of gasworks, ironworks, &c., the ammonia of which is passed into sulphuric acid, is another typical chemical manure. The term is also applied to the potash manures, muriate and sulphate of potash, and to nitrate of soda, all of which are manufactured from natural salts by chemical processes. Kainit, though it is a natural salt which has not undergone any chemical process of preparation, but is merely graded and crushed, is also generally classed as a chemical manure. See ARTIFICIAL MANURES. [J. H.]

Chemistry, Agricultural. — Agricultural chemistry may be defined as chemistry in its application to agriculture. For a proper understanding of it there must be a knowledge of the main principles of the science of chemistry, for, just as the latter concerns itself with the investigation of the composition and properties of various kinds of matter, so does agricultural chemistry, though in the more limited yet more special field of agriculture. The principles of the two are the same, and extension of knowledge in the one implies its wider application to the other. Until chemistry came to be formulated as a science there could be no science of agricultural chemistry, but with the discovery of oxygen by Priestley in 1774 there soon began that investigation into the conditions of plant life, and its relations to the matter by which it is surrounded, with which agricultural chemistry at the outset mainly concerned itself. Already at that time a large store of facts had been built up by the practical farmer, which he made use of in his daily work, but these were only the outcome of experience, the accumulated result of the labours of many generations, and he was unable to explain or to extend them. Then it was, however, that science with its discoveries came in to supply the explanation of what had been learnt empirically, and to open the way to the wider application of the principles involved. Nor did investigation cease with the consideration of plant life and growth, but, as knowledge increased with regard to the atmosphere and its constituents, so the soil and the materials of which it is composed came next to be studied, and then animal life in its turn, until the whole was gradually shaped into the science of agricultural chemistry as we have it to-day. In this building up of the new science, not chemistry alone but other sciences, such as geology, botany, physics, and physiology, have had their share, and the latest addition to the list, viz. bacteriology, has shown that the soil is not the inert mass it was at one time supposed to be, but is in reality a storehouse of bacterial activity. Hence agricultural chemistry cannot stand alone, nor in reference only to the science of chemistry, which gave it birth, but it has become dependent on other sciences too, a knowledge of which is essential to its proper understanding and development. It has been pointed out that while chemistry concerns itself with the nature of bodies, the combinations they form, and the changes they undergo, so too must agricultural chemistry. But in many ways there is a wide difference in the scope of the two, and agricultural chemistry works in a much narrower sphere. Thus, while chemistry concerns itself with some seventy or more elementary bodies, or 'elements' as they are termed, the domain of agricultural chemistry covers but some fourteen or fifteen of these. The number of these is, however, widening, and recent work seems to indicate that other elements than those usually dealt with in agricultural chemistry will come to play a part later on. Of the elements, we are at present concerned practically with only the following: oxygen, hydrogen, nitrogen, carbon, potassium, sodium, calcium, magnesium, iron, aluminium, chlorine, sulphur, phosphorus, and silicon. Nor is there in agricultural chemistry the more or less definite division, so familiar in the pure science of chemistry, into inorganic and organic bodies.

Agricultural chemistry concerns itself mainly with four branches.

1. The atmosphere, as supplying food to the plant and the animal.
2. The soil, in its relation to the growth of plants.
3. Plant life.
4. Animal life.

To follow out the development of the application of chemistry to each of these branches would be to write the history of the science and to give an account of the work which each investigator has contributed to the common store. This can be but rapidly touched on.

The discovery of oxygen by Priestley in 1774 gave the first start to the formulating of definite knowledge regarding the sources from which plant life derives its nourishment, and so led on to the study of the different constituents of plants, the changes and elaborations which they undergo and exhibit, and the relations of plant life to the conditions surrounding it. Already various phenomena had been observed, and in the practice of agriculture many sound principles had been for long incorporated, but without the real explanation being in either case forthcoming. It was Bonnet who, previous to Priestley's discovery, had noticed bubbles of gas to rise off the surface of leaves of growing plants when these were immersed in water; these bubbles were now shown to consist principally of oxygen gas. Closely on this followed, chiefly by the labours of Black, Scheele, Lavoisier, Cavendish, and others, the discovery of the composition of air, of water, and of carbonic acid, and the researches that followed on these discoveries led to an understanding of the relations that exist between these bodies and vegetation. With these early researches the names of Sennebier, Woodhouse, and Ingenhousz, as well as Priestley, are associated. It was Sennebier who showed that carbonic acid is decomposed by growing plants, and that oxygen gas is given off, while Ingenhousz demonstrated that light is essential for the process to go on. Priestley showed, too, that plants possess the power of purifying air that has become vitiated through the respiration of animals or by combustion, and that oxygen gas is then given out from the plants.

The next great step forward was the study of the influence exercised by the surrounding media on the actual increase of material of the plant—the study, in effect, of the ways in which plants build up their structure. In this work the name of De Saussure is the most prominent, and he it is who may justly be regarded as the first 'agricultural chemist'. His researches, published in 1804—Recherches Chimiques sur la Végétation—contain the first definite information we possess regarding the sources of the constituents which the plant stores up during its growth. In these we have the first indication of the destiny of the carbonic acid of the atmosphere, for he showed how the carbon is assimilated and built up to form, with water, the carbohydrates of the plant, the relation between the carbon supplied and the carbohydrates produced being one of quantitative nature. It was De Saussure, too, who first drew attention to the importance of the mineral constituents of plants, and who was led to the conclusion that these were derived from the soil. To some extent he contributed also to the question of the part played by nitrogen in vegetation, concluding, however, that it was not absorbed in the free state from the atmosphere, but that plants derived what nitrogen they had from the soil, or, possibly, from the ammonia in the atmosphere, the presence of which he had shown. The soil thus was to De Saussure the supplier of the mineral and nitrogenous ingredients, but air and water the sources from which the bulk of plant substance and increase was obtained. Priestley and Ingenhousz, it may be said, were led to think that plants took up free nitrogen from the atmosphere, but Sennebier and Woodhouse thought differently. Hence, even at this early period, the 'nitrogen question', which of late years has had so much attention drawn to it, was a debated one.

About this same time Sir Humphry Davy by his lectures on agricultural chemistry (1802–12) did a great deal to draw attention to and popularize the study of agricultural chemistry, without, however, adding much himself of original nature to its development. In Germany, too, Carl Sprengel, from the year 1826 on, issued a series of papers on chemico-agricultural subjects, and published many analyses of agricultural materials. Despite the work done by De Saussure, and the recognition of the carbonic acid of the atmosphere as being that from which plants derive the bulk of their increase, there came in next a period when the so-called 'humus theory' held sway, its chief exponent being Albrecht Thaer. According to Thaer, the humus of the soil was the universal nutrient of plants, and the inorganic bodies acted merely as stimulants, without being in any way essential. But Thaer was more a man of a practical turn than a writer on science, and it is to him that we owe the first attempts to assign definite values to materials used for farm feeding purposes. The 'humus theory' did not long hold its ground, for Boussingault first, and then Liebig, entirely upset it. The advent of Boussingault on the scene in 1834 marked a new epoch in agricultural science, and for many years his researches formed the most important contributions to the advance which was made. It was he who first drew attention to the amount of nitrogen which different foods contained, and he attempted the assessment of their relative values on the base of their nitrogen contents. The gluten in wheat and its amount next engaged his attention, and such large subjects as the weathering of rocks in regard to soil production, and the influence of meteorological conditions as affecting cultivation were taken up by him. After this came his great work on the rotation of crops, and Boussingault it was who first put out in a definite manner the principles which underlie the practice of rotation. In doing this he investigated both the composition of the actual crops grown and of the manurial materials applied to them. After this he was led to enquire into the question of the assimilation of the free nitrogen of the atmosphere by growing crops, and he came to the conclusion that this did not take

place. Another matter that concerned him was the determination of the constituents composing the diets of milking cows and horses and their relation to the milk supplied by a cow, and the matters excreted by the two kinds of animals. Altogether the range over which Boussingault's enquiries extended was of a very wide nature, and indeed was wider than the then known methods of chemical analysis allowed of accurate determination.

It was about this time that Daubeny was delivering his lectures at Oxford University. It was these lectures that J. B. Lawes, then a young man, attended, and they no doubt gave him the stimulus to initiating those world-known enquiries with which the names of Lawes and Gilbert will ever be associated.

With the foundation of the science thus carefully laid by men like De Saussure and Boussingault, there then came, in 1840, that brilliant exponent, Justus von Liebig, to whom was due, in greater measure than anyone else, the bringing into prominence and the popularizing of agricultural science. The energetic way in which he forced his theories on general notice, and the brilliancy of his mode of expressing them, gave to them a prominence which had not before been attained, and his writings caused the most widespread interest. In 1840 appeared Liebig's first report to the British Association, and was entitled 'Chemistry in its Application to Agriculture'. In it he dealt mainly with the question of from whence the plant derives its food, and he showed the insufficiency of the former 'humus' theory to explain the supply of the needs of plant life. The humus he showed to be only with difficulty soluble, and that plants could at best utilize a small quantity of it, this amount depending on the extent to which oxidation went on. Similarly he examined the question of the supply of hydrogen, of oxygen, and of nitrogen to the plant, and what their various sources were, and, like Boussingault, he concluded that free nitrogen was not assimilated by plants; the hydrogen he attributed to water, and the oxygen to water or the decomposition of carbonic acid. Under his fierce onslaughts the 'humus' theory was demolished, and in place of it Liebig put forward his famous 'mineral theory', a theory in its turn to be displaced later by the 'nitrogen theory' of Lawes and Gilbert, though only after a long and, at times, bitter struggle. At first Liebig was disposed to attribute some importance to the nitrogen supplied to the land as manure, but he always considered the ammonia brought down in rain to be the main source of nitrogen supply; and in a second report (1842) he went further, and maintained that cereal as well as leguminous crops could obtain all the nitrogen they needed from the atmosphere and did not require to have nitrogenous manures applied to them. In this way Liebig was led to insist most strongly on the importance of the supply of the inorganic or 'mineral' constituents to plant life, this being in effect the 'mineral theory' associated with his name. Meanwhile Boussingault, working in conjunction with Dumas, was endeavouring to show the importance that was to be attached to the nitrogen in manures, and later on he was joined in this by Lawes and Gilbert, whose joint work dates from the year 1843, the same year in which Liebig's third report to the British Association appeared. There can be no doubt that the 'mineral theory' of Liebig had much to support it, and it was greatly aided by the brilliancy of the exposition given by its author. Thus Liebig showed how differences of soil were due to the weathering of the rocks from which they were derived, and that the ash of plants varied in composition according to the soil on which they were grown; while the benefit of fallowing land was attributed by him to the fact that the mineral constituents of the soil gradually became available for the plants, so that they could be taken up. On this was built the theory of the excretion by one kind of plant of matter which it did not require, but which in turn might be useful for another kind of crop, thus explaining the benefits of a rotation of crops. Against such theories, with much to commend them, and put forward, as they were, supported by the genius and advocacy of a Liebig, nothing less than the continued and careful work of patient investigators like Lawes and Gilbert could prevail. But this was ultimately triumphant, and it is to the famous Rothamsted field experiments that we owe the abandonment of the 'mineral theory' in favour of the now universally accepted 'nitrogen theory' of Lawes and Gilbert, in which, however, we must not forget the association of Boussingault.

The impetus given first by Liebig had its immediate influence in the commercial world, for, adopting the suggestion of Liebig made at a meeting of the British Association, Thomas Proctor, then of Bristol, started the manufacture of dissolved bones by treating bones with oil of vitriol, and in 1842 Lawes himself extended this to the treatment of mineral phosphates, and so laid the foundation of the great industry of the manufacture of mineral superphosphate.

Before passing from Liebig's work it should be mentioned that it was not to the chemistry of the plant and the soil alone that he paid attention, but that his researches extended to the field of animal chemistry also. Thus he showed the relations of plant and animal life, and the identity of the nitrogenous constituents in plants with those built up in the animal body, while he supplied the explanation of the production of heat in the animal body. In studying and contrasting the general composition of plants and animals, Liebig was led to supply a possible explanation of the differences between carnivorous and herbivorous animals in respect of the use which they respectively made of the constituents of their food, the carnivora, he believed, obtaining the material for respiration mainly from the waste of tissue, and hence not growing fat, while in the case of the herbivora, the starch, sugar, and other carbohydrate matter supplied the material for respiration, leaving the other constituents available for body increase. Liebig was thus brought to divide the constituents of food into two great classes—the nitrogenous or nutrition-supplying bodies, and the non-nitrogenous or respiratory elements. In this con-

clusion he was much aided by the researches of Mulder, who was then working on the protein compounds. From this point Liebig proceeded to give the demonstration of the various changes which food constituents undergo in the animal body, and the metamorphoses of the different parts of the animal body. Later on he developed the theory of the cause of motion, or expenditure of energy in the animal, and regarded this as being dependent upon the amount of nitrogenous matter supplied.

Lastly, in thus summarizing Liebig's work, mention should be made of his study of the processes of fermentation and decay. To these, however, he attributed a purely chemical origin, a position since shown to be untenable.

From the account thus rapidly given it will be seen how immense was the impetus given by Liebig to future investigation in the field of agricultural chemistry, and how from his time may be dated its development, largely upon lines suggested through his own activity. From this period may be said to have commenced the organized system of agricultural enquiry which has since, in different countries, been pursued to a greater or less extent, and the importance and need for which is being more and more recognized. At the outset much was dependent on private enterprise and encouragement, and, so far as the United Kingdom is concerned, the recognition by the State, in any form whatever, of the claims of enquiry, has been, and still is, very tardy and very partial. On the Continent and in America, however, the value of such work was recognized at a much earlier date, and was far more liberally endowed.

John Bennett Lawes, on succeeding, in 1837, to his estate at Rothamsted, Herts, began at once, by experimenting with plants growing in pots, the series of investigations which became later so famous. These were extended in 1841 to the field, and in 1843 Lawes was joined by Joseph Henry Gilbert, from which date began that long association which was only broken by Lawes's death in 1900, Gilbert following his fellow worker a year later. In 1843 were begun the field experiments at Rothamsted on wheat and roots, followed in 1847 by those on beans, and in 1848 by the series on clovers and other leguminous plants, as also on barley. In 1848 were commenced the feeding experiments on animals, whereby were established the data for reckoning the respective proportions of the constituents of food stored up in the animal body or excreted as manure. The experiments on grass land followed in 1856, and these, with the aforementioned field experiments, have, with but little change, been continued in unbroken succession to the present day.

The history of the Rothamsted field experiments has been that of the development of a rational system of manuring the land. Not only did Lawes and Gilbert, in opposition to Liebig, show the important function played by nitrogen, as supplied in the form of manure to the land, but they also, by their long-continued experiments on the different classes of crops grown on the farm, demonstrated the parts played by the mineral ingredients of the soil or of manures, establishing that for most purposes of practical farming the essential constituents were phosphoric acid and potash. On these ascertained facts has been based the compounding of and trade in artificial manures, and it is not too much to say that the universe has ever since been exploited in order to find materials which shall, either in their raw state or as manufactured and compounded, serve the purposes of the manuring of agricultural crops.

Confirmation has been supplied to the Rothamsted work by the Woburn field experiments, which in their turn have given further useful information, notably in regard to the value of lime, and the exhausting effects of ammoniacal salts when used continuously. On the experiments at Rothamsted is based much that we know of rotation, while to these and the feeding experiments is due the calculation of the unexhausted manurial value resulting from the consumption of purchased foods on the farm, a subject to which further results obtained from the Woburn field and feeding experiments have materially contributed.

The Royal Agricultural Society of England appointed in 1843 their first consulting chemist, this being Dr. Lyon Playfair (afterwards Lord Playfair), and to him succeeded, in 1848, Prof. Way, and in 1858 Dr. Augustus Voelcker, who held the post until his death in 1884. What the field and other experiments of Lawes and Gilbert supplied for the scientific enquirer in agriculture, the Royal Agricultural Society was enabled, by its successive consulting chemists, to bring into the ordinary practice of its members and the agricultural public generally. Way's work on soils and drainage waters had an important influence in this direction, while the name of Augustus Voelcker will always be remembered as that of the one, in this country, who showed the practical farmer how the teachings of science might be brought to bear upon his everyday work. From this time there came to be a better knowledge of the action of manurial substances and of the properties of different feeding materials, and the trade in these became a regular and organized one. Also a great stimulus was given to field experiments on individual farms and on different soils. In 1876, through the liberality of the then Duke of Bedford, the Royal Agricultural Society of England was put in possession of its own experimental farm, and the Woburn Experiments, which may be taken as a supplement, though on very different soil, of the Rothamsted Experiments, have been continued ever since. Feeding experiments on animals as well as field work are carried out, and in 1897 a pot-culture station—the first in this country—was established.

It is only within the last few years, however, that anything has been done through State help, and agricultural chemistry has had to rely, for its development, purely upon private enterprise and the support of leading agricultural societies and educational institutions. Of recent years, however, the Board of Agriculture has made small grants to agricultural colleges carrying out experimental work in agriculture.

Meantime, in France, the work of enquiry

had been greatly aided by the researches of Ville, Berthelot, Schloesing, and Müntz, the two former being specially active in regard to the question of nitrogen assimilation, and the two latter in the matter of nitrification. In Germany the first experimental station was started in 1852 at Möckern, and, fostered by the State, many others have since been established throughout the country. With these the names of Wolff, Kühn, Kellner, Knop, Nobbe, Frank, Hellriegel, and Maercker are closely associated. The three first-named have worked principally in the field of animal nutrition, and it is to Wolff largely that we owe such knowledge as we have in regard to the consumption of food in the production of energy in different forms, and of the digestibility of the constituents of different foods. Knop and Nobbe will be remembered by their work in the domain of water-culture of plants, and Frank by his contributions to the nitrogen-assimilation question. Hellriegel and his colleague Wilfarth gave to us the solution of the problem of the assimilation of free nitrogen by leguminous plants, a problem long and hotly debated since De Saussure's time by Boussingault, Liebig, Lawes and Gilbert, Ville, Frank, and others. Still later came Maercker, who was to Germany much what Augustus Voelcker had been to England.

The first experimental station in America was established in 1875 at Middletown, Connecticut, and in that country—so differently from our own—agricultural research has received almost unbounded encouragement, so that, although the period over which the work has extended has been less, it has been marked by great activity, and every State has its own experimental station. The names of Atwater, Hilgard, Henry, and Wiley stand out prominently—Atwater in connection mainly with the 'nitrogen question', Hilgard with his admirable work on soils and soil physics, Henry with cattle feeding, and Wiley with soils and agricultural analysis.

In these ways, and in different countries simultaneously, the pursuit of enquiry in agricultural chemistry has been carried on, and will continue. True it is that since the time of Liebig and his contemporaries, followed up by the work of Lawes and Gilbert, great discoveries in agricultural chemistry, with two or three exceptions, have not been of the startling character of those of the earlier days; but the whole line of progress has, at the same time, been marked by great care and testing of results, methods of analysis have been greatly improved, and ascertained facts have been more definitely set out. Of a few of the principal developments since Liebig's time mention should now be made, and first among these comes the 'nitrogen question'. Lawes and Gilbert by the Rothamsted field experiments were able to prove, beyond doubt, that the 'mineral theory' of Liebig was incorrect, and that nitrogen was the great factor in the growth of cereals, the atmosphere and the soil not providing a sufficiency, but this having to be supplied in the form of manure. They showed that, provided a sufficiency of mineral constituents were present in the soil, or supplied by manure, the crop increase above the normal was measured, not by the minerals present, but by the nitrogen supplied as manure. But, though correct in this, Lawes and Gilbert were not equally so in regard to the question of the assimilation of free nitrogen by plants. A most complete series of investigations by them, in conjunction with Pugh, led them to conclude that plants did not assimilate free nitrogen. In this they were supported by Boussingault, and in this condition the question remained, though now and again workers such as Ville, Voelcker, Atwater, Frank, and others ventured to question the conclusions, and to point out that the luxuriance of a cereal crop following on the growing of a clover crop could not be explained without supposing some further supply of nitrogenous food than that provided in seed, soil, manure, or rainfall. It was left, however, to Hellriegel and Wilfarth, by a series of brilliant and careful investigations, to show in 1887 that certain of the Leguminosæ at any rate did possess the power of assimilating the free nitrogen of the atmosphere, and this by the action of bacteria and the resulting production of nodules on the roots. These observations were confirmed by others, and were finally allowed by Lawes and Gilbert, who repeated their work, and then found out that the precautions which they had taken in their earlier experiments to exclude outside agencies had rendered the conditions impossible for the presence of that bacterial life on which the assimilation process depended. The truths thus brought out by Hellriegel have now received ample confirmation, and have established the case as regards the assimilation of free nitrogen by the Leguminosæ, though the question is still unsettled in regard to other cultivated plants.

The rapid rise, in recent years, of bacteriology as a separate branch of science has been productive of the greatest benefits to the cause of agricultural chemistry, and it is in the direction of the application of bacteriology to agricultural chemistry that the greatest advance is, at the present time, being made. One outcome of this has been the attempt to prepare inoculating material for promoting the growth of leguminous crops, and, though this has not as yet reached the point of practical application, there is already indication that it will eventually be successful. Whether something of the same kind will be applicable for non-leguminous crops also still remains to be seen.

Another great discovery in the same field of research was the explanation of the process of 'nitrification' as carried on in soils, &c. It was Schloesing and Müntz who first showed in 1877 that nitrification was effected by the presence of a definite organism in the soil which converted the nitrogenous organic material in the soil into nitric acid. The subject was further investigated by Warington, who ascertained that the process took place really in two stages, the first resulting in the formation of nitrites, and the second being the further conversion to nitrates. It was left to Winogradsky and to P. Frankland to ultimately isolate and describe these organisms, while Berthelot and other workers investigated and set out the conditions

under which the organisms acted. Still later, discovery has been made of other organisms, such as *Azotobacter chroococcum* and *Clostridium*, which, existing in fertile soils, have themselves the power, when suitably supplied with carbohydrate material, and without (as in the case of the leguminous organisms) the intervention of a host plant, of assimilating free nitrogen also.

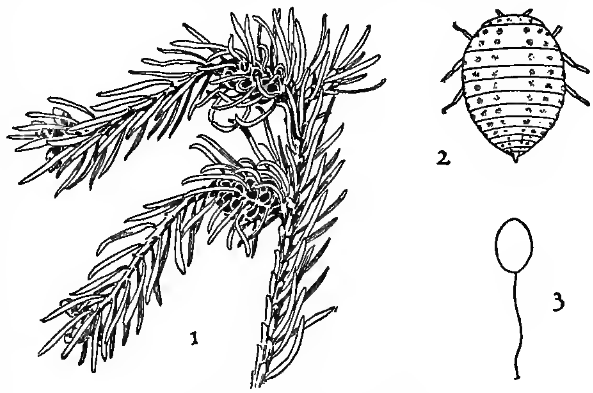
Another side of agricultural chemistry which has shown considerable development of late years is that of the physical relations of soil; and important as undoubtedly is the matter of the presence of the necessary elements of fertility in a soil, it is also the case that equal, if perhaps not even greater, attention must be paid to the mechanical and physical relations of soil, in respect of the rendering available of the food stored up in it or supplied as manure.

Agricultural chemistry, as has been shown by the foregoing, concerns itself therefore primarily with the conditions of plant life in its relation to the supply of food from the atmosphere, from the soil, and from outside sources such as manure, and with animal life in its relation to food supplied, the purposes which the constituents of foods serve, and their ultimate destination in the animal organization. [J. A. V.]

Chenopodiaceæ.—This is the botanical name for the nat. ord. of dicotyledonous plants which includes the Mangel and Beet. The distinctive characters are: (1) The flower has no petals; (2) usually each flower has stamens and pistil (except Spinach, &c.); (3) the plants are herbs; (4) the leaves have neither wing-like nor tubular appendages at the base (*exstipulate*). Many are strand plants or occur on soils containing much salt, such as the Asiatic salt steppes and deserts. Mangel and Beet are cultivated descendants from maritime ancestors. The cultivated plants are: Spinach, or Spinage (*Spinacia oleracea*), a hardy annual cultivated for its large fleshy leaf; Sugar Beet (*Beta vulgaris* varieties), a biennial cultivated for the 'roots', which yield beet sugar; Mangel (*Beta vulgaris* varieties), a biennial also cultivated for 'roots'. The common weed plants are: White Goosefoot (*Chenopodium album*), an annual of waste land; Good King Henry (*Chenopodium Bonus Henricus*), a perennial of rich land; Red Goosefoot (*Chenopodium rubrum*), an annual of waste land. [A. N. M'A.]

Chenopodium. See Goosefoot and Chenopodiaceæ.

Chermes abietis-laricis (Larch and Spruce Gall Aphis), an aphis which causes the curious pineapple- or cone-like galls on the common spruce trees. The females appear in spring after hibernating amongst bud scales, &c., and lay their eggs in masses at the tips of the shoots and at the base of the needles of the young shoots. The eggs are stalked, and to some extent covered with wool; the lice coming from them puncture the base of the needles and cause them to swell up at their bases, and by degrees the pineapple-like gall is formed. As the swollen needles unite at their bases, there are formed chambers in which the lice live and grow; each chamber eventually contains a number of aphides and becomes lined with a mealy substance and oil globules. The 'cones' are at first pink and green, and then harden and become brown. They may grow to an inch or more in length, and may contain as many as 2000 inhabitants. In June, July, and August the galls open, and pupæ and winged females escape and the latter fly from tree to tree. The winged females lay eggs towards autumn on the apices of the needles, covered with white wool. Larvæ coming from these either die or hibernate in the base of the buds. A minute blind apterous male occurs. The sexual egg is always laid on the Spruce.



Spruce Gall Aphis (*Chermes abietis*)

1, Part of infested spruce shoot (half natural size). 2, Adult female, winter generation. 3, Egg laid by female of winter generation.

Some of the Spruce form or race fly to the Larch, and there they become the so-called Larch Aphis, which produces the small white flecks of wool so abundant on the Larch needles in summer. The aphis hibernates under the leaf-scales and commences to oviposit in April and May; the eggs are laid in groups and are pedunculate; they hatch in late May and early June, and the small black larvæ often cause the needles to elbow near the middle. By the end of May they commence to change to pupæ and have white wool over them, and from June to August winged females arise, which are oviparous. Some of these fly to other Larch, some to Spruce and set up the *abietis* race. Thus there is a migration between the Spruce and the Larch, the *Chermes abietis* and *C. laricis* being alternating generations of the same insect. Bark is also said to be attacked by *C. laricis*, but the probability is that this is a distinct species, known as *Chermes viridis*.

Treatment.—Larch trees may be sprayed with paraffin emulsion to kill the larch form, and the galls may be hand-picked from the Spruce before the aphides escape. Paraffin emulsion may be made for this purpose by dissolving 6 lb. of soft soap in boiling water, and then churn in 8 gal.

of paraffin, and add water up to 100 gal. Larch and Spruce should not be planted together, but separated by belts of hardwoods. [F. V. T.]

Cherry.—The cultivated cherries are descendants from two species of Prunus which grow wild in Europe, including the British Islands, namely *P. Cerasus*, the progenitor of the Morello and Duke cherries; and *P. Avium*, the progenitor of the Gean and Bigarreau varieties (see art. CHERRY, THE WILD). According to Pliny, the Cherry was introduced into Britain by the Romans, who are said to have obtained it from Cerasus, in Armenia. Cultivated or improved varieties, however, do not appear to have been known in England before the time of Henry VIII, when several were introduced from Italy into Kent. There are now over a hundred named varieties of cherries in cultivation in English gardens alone, some of the best of them having been raised by the late Mr. Rivers of the Sawbridgeworth nurseries, a most successful breeder of fruits.

The cherry orchards of Kent are famous for the quantity and quality of the fruits they yield. In Germany, France, Italy, and Belgium, cherry trees are not only grown in orchards, but they are also largely planted along roadsides, as plantations for shelter and shade, and on railway embankments, being very easy to satisfy, beautiful objects when in flower, and most prolific bearers of marketable fruit.

The Cherry is the first among popular fruit trees to ripen its fruits, and no fruit is more highly esteemed. It may be eaten as dessert, cooked in pies, made into jam or jelly, or preserved whole in bottles. The celebrated Kirschwasser liqueur of Germany is made from cherries pounded in a wooden vessel and left till the mass ferments. The kernels are broken and mixed with it, and a liquor is then distilled from it. Maraschino, a liqueur prepared chiefly in Dalmatia and several other portions of the Austrian empire, is made from small black sour cherries by fermentation and distillation, wine being added before distilling, and the spirit being also sweetened. In this country, cherries are most valued as a dessert fruit. Not only do the supplies from our own extensive orchards obtain a ready sale, but thousands of tons are annually imported from various European countries also.

It is usual to graft the best varieties of cherries on stocks of seedlings, for although the seeds germinate readily they cannot be relied upon to yield good-quality sorts. It has been stated that the Cherry varies more when raised from seeds than any other tree. All the best varieties raised in England were obtained in this way. For dwarf trees the most suitable stock is the Mahaleb, whilst the Morello is the best for ordinary orchard trees. It is, however, advisable to consult local experts as to the best sorts of Cherry and the most suitable stock for any given locality, the nature of the soil and peculiarities of climate affecting the growth and health of the trees, for whilst all may do, some are certain to do better than others.

The ideal site for a cherry orchard is a sunny slope where the soil is a deep rich loam overlying a calcareous sandstone, or where lime or chalk is present in some form. These are the conditions in those parts of England where cherries are most successfully grown, as, for instance, in Kent, Hertford, Buckingham, &c. 'A free deep soil suits the Cherry. It prefers rainwash — detritus worn from hillsides, incumbent on rock; soft, sandy loam underlaid by sand; light, mellow soil overlying sandstone; deep loams interspersed with calcareous matter; and loams commingled with flints, and well drained' (J. Wright). The soil should be prepared by trenching or deep ploughing, and when the trees are being planted a hole at least one yard wide should be dug, and the soil well broken to a depth of 2 ft. Standard trees intended to grow to a large size should be set from 25 to 30 ft. apart; bush or pyramid trees about 12 ft. apart. Each tree should be supported with a stout stake fixed firmly at the time of planting. Trees to be grown on walls should be standards with fan-trained heads and planted 12 ft. apart. In purchasing cherries it is advisable to procure them from dealers who take pains to grow shapely young trees, grafted on the stock known to be most suitable to each variety, and treated so that they form a good healthy mass of roots. The planting may be done as soon as the leaves begin to fall, spreading the roots evenly and taking care to work the soil in amongst them. The standards will not require any pruning after the head has been formed, which probably has been done in the nursery. Should any shoots start on the stem these must be removed. Trees trained against walls require more attention. Summer pruning is better for these, by which is meant the entire removal in July of all superfluous shoots, and the shortening of others that are growing too vigorously. If this is attended to in summer, no further pruning will be necessary beyond shortening the longest shoots to a length of 3 in., leaving uncut those shoots which are for extension. The distance between the shoots on a wall-trained cherry tree should be about 9 in. Established trees soon exhaust the soil about their roots unless it is enriched annually with a good dressing of well-rotted farmyard manure put on during the winter. A dressing of basic slag is good for orchard cherries.

Birds are very troublesome to cherry-growers. Netting the trees is absolutely necessary where birds are abundant, otherwise all the fruit will be stolen. The gun must be freely used in orchards during the period when the fruit is ripening. A black aphis, commonly called the cherry louse, often infests cherry trees, swarming on the upper portion of the young shoots, causing the leaves to curl and abort (see MYZUS CERASI). The larvæ of the Cherry Sawfly (see ERIOCAMPA LIMACINA) is also troublesome in some years. Another insect enemy is the Cherry-tree Case-bearer (see COLEOPHORA). These may be kept in check by the timely application of insecticides, using for the purpose one of the spraying machines, of which there are now several that are both cheap and simple.

Cherries are sometimes grown under glass, either planted in borders and trained under the

roof as in the case of peaches, or in pots and grown as pyramids. This, however, is a fanciful kind of gardening indulged in only by the wealthy amateur.

The best varieties of cherries are:—

Archduke.—Fruit dark-red, flesh tender, rich and juicy. Ripe in July.

Bigarreau.—Fruit large, white and red, flesh firm, sweet, and rich. Napoleon is a form of it, with larger fruit of a darker shade of red. Ripe in August.

Black Tartarian.—Fruit black, flesh soft and juicy. Ripe in July.

Downton.—Fruit yellow, mottled red, flesh white, rich flavour. Ripe in July.

Early Rivers.—Fruit black, in large clusters; richly flavoured. Ripe in June.

Elton.—Fruit yellow, mottled red, flesh firm, sugary. Ripe in July.

Kentish. — Fruit medium, bright-red, flesh pale, acid. Ripe in July.

Knight's Early Black.—Fruit black, flesh deep-purple, firm, rich. Ripe in June.

Late Duke.—Fruit large, shining-red, flesh amber, rich, slightly acid. Ripe in August.

May Duke.—Fruit roundish, dark-red, flesh red, rich, juicy. Ripe in July.

Morello.—Fruit heart-shaped, dark-red, flesh purple-red, juicy and acid. Ripe in July, but will hang till October on a wall tree facing north.

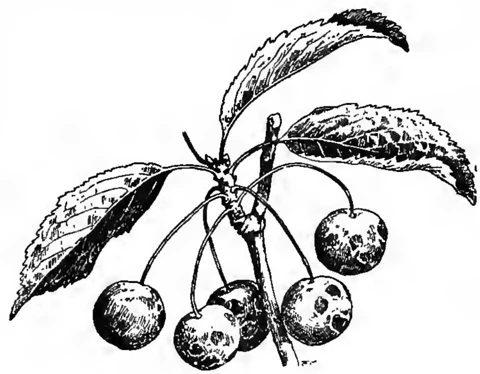
Royal Duke.—Fruit shining dark-red, flesh reddish, tender, very rich. Ripe in July.

Waterloo.—Fruit purple and red, flesh rich and sweet. Ripe in June. [W. W.]

Cherry.—Parasitic Fungi.—

Leaf Fungi.—The foliage of wild and cultivated cherries is frequently damaged, it may be by drying winds or late frosts, or from the use of insecticides; on the other hand, fungi may be the cause. Cherry Leaf Scorch, very destructive in the south of England, has been traced to *Gnomonia erythrostoma*, an Ascomycete fungus. In summer the leaves appear scorched and the fruit is of poor quality, but the most evident symptom is that the brown withered leaves remain hanging on the tree all winter; these bear the ascus fruits, which carry the fungus over the winter and infect new buds next season. The collection and burning of dead leaves has proved a successful remedy, but only if carried out all over the district. Certain varieties are more sensitive than others; in one case a writer states that 'Waterloos' were rendered useless in a few years, whereas 'Turks' in the same orchard were almost untouched. An excellent illustrated account of this disease and its treatment is given by E. S. Salmon (South-Eastern Agricultural College Journal, July, 1907). This writer obtained excellent results by collecting and destroying the dead leaves in winter, and by spraying with Bordeaux mixture (see Fungicides) just before the flowers open, and again after they have fallen. This treatment would at the same time prevent other leaf fungi sometimes found on cherry, such as Powdery Mildew (see Apple), Rust (see Plum), and several species which cause 'shot-hole' perforation of the leaves.

Fruit Rot.—The usual form is Brown Rot, due to *Monilia fructigena*, an enemy of many fruit crops (see Apple). The flower is attacked, whole branches becoming coated with greyish masses of spores, whereas neighbouring trusses are untouched. Other signs of this disease are that shrivelled flowers, stunted fruits, and a few withered leaves remain hanging on the twigs; there is usually also a large amount of immature dead wood. Salmon found the greatest destruction on acid cherries; he restored trees to health in two seasons by spraying with Bordeaux mixture before and after flowering; emphasis is also laid on cutting out and burning diseased twigs before the leaves fall in autumn. This treatment will also be effective as a remedy for Cherry Scab (*Fusicladium cerasi*), a minute fungus which has frequently caused much injury to the fruit.



Cherry Scab

Brown scabs on the fruit caused by *Fusicladium cerasi.* (By permission of Board of Agriculture.)

Branch and Stem Diseases. — Witches' brooms are common on wild cherry trees; they are dense hanging masses of twigs with upturned ends, and bear leaves but no fruit. Young leaves bear the asci of *Exoascus cerasi*, an Ascomycete (see Fungi). These branches may be removed by pruning.

Gummosis is a form of canker frequently found on Cherry, Peach, and other species of Prunus. The first symptom is oozing of gum from the bark, and this accumulates to form large sticky masses. Cavities filled with gum are also formed in the bark and wood, and the latter becomes much darker in colour. If gummosis proceeds far enough the passage of sap ceases, and the branch dries up during winter or even in summer. The first cause is probably wounds, but several fungi have been found on the cankers. Diseased branches should be removed by cutting some distance below the lowest cankered place, the cut ends afterwards being dressed with tar. The soil may also require attention; in several cases of gummosis on Morello we have found this to be in bad condition. [W. G. S.]

Cherry, the Wild, or **Gean Tree** (*Prunus Avium*) and the **Bird** or **Wild Black Cherry** (*Prunus Padus*) are two indigenous,

wild-growing, woodland tree-species of the Prune genus of the Amygdalaceæ tribe of the Rosaceæ family, a genus to which the Blackthorn shrub (see BLACKTHORN) also belongs. They are easily recognizable by the transverse lenticellular markings on their smooth bark, which in the Gean Tree splits and curls off in thin horizontal strips round the stem, and by their pretty tufts of stalked white flowers in early spring, or of red drupe fruits in July, or their red-yellow leaves in autumn. The Common Wild Cherry or Gean, the larger of the two species, is extensively found in hedgerows and also in woodlands among the timber-trees, where it sometimes attains large dimensions (up to about 70 ft. high and over 8 ft. girth, and containing 2 tons of timber, in Gloucestershire). It differs from the other species in having larger leaves and petioles, larger and redder glands on the leaf-stalk, and larger, ruddier, and sweeter cherries, while its wood is harder and of a darker yellowish-brown colour. It takes a fine polish, and is prized for furniture, turnery, and instruments. It grows rapidly on any fairly dry soil, and does well on lime; and it forms a clean and straight stem carrying an oval crown of light foliage, and usually lives to about eighty years of age. It flushes freely from the stool, and is therefore often found in copsewoods, and in some places it throws up suckers as well as coppice-shoots. But it is a light-demanding tree, and therefore not really a good class of underwood. It can be easily grown from seed by sowing the cherry stones soon after the fruits ripen in July; and young seed-grown saplings form good parent stocks on which to graft the finer kinds of cherry for orchard planting. The smaller species, the shrub-like Bird or Wild Black Cherry, is highly ornamental in parks, where its long hanging racemes of white flowers in spring and its rich red foliage in autumn are very effective. It can endure more shade than the Gean, and is therefore more suitable for underwood, as it coppices freely and also throws up suckers oftener. It grows quickly, but is seldom over 25 to 30 ft. in height. Its bark is more odorous of oil of almonds, and its small, black, pea-sized cherries are bitter-sweet in taste and astringent. It grows best on fresh or moist soil, whereas the other and larger species of Wild Cherry does best on drier land. [J. N.]

Chervil. See CHÆROPHYLLUM.

Chervil (Rough). See ANTHRISCUS.

Cheshire Cheese.—Cheshire has for long been noted for the excellence of its cheeses, and as a class Cheshire cheese may certainly be said to stand second to none of the hard pressed varieties. It is a cheese possessing very distinct characteristics both as regards texture and flavour, for while it is very open-grained it is yet soft, mild, and full of quality. As now made, it is perhaps the softest of our hard-pressed varieties, a state of affairs due more to change in consumers' tastes than to old-time customs. The excellency of the cheese may be ascribed partly to situation, but more especially is it due to the skill of the makers, many of whom are possessed of the experience gained in the art by a long line of ancestors. This inherited lore, added to the opportunities afforded during the last two decades to gain through technical education a more intelligent understanding of the principles involved, has served to place the cheesemakers of Cheshire in a class by themselves, in that they perhaps more than any others have shown themselves able to adapt their produce to the requirements of the market. Thus during the early season a quick-ripening cheese is made, later on a medium-ripening, and yet later a slow-ripening one is produced. The cheeses are made both with and without colour; as a general rule those made on the east side of the county and serving the Manchester market are not coloured, while those made on the west are almost all coloured. There are therefore three types of Cheshire cheese, which are coloured or not, according to market requirements. In all cases the cheese is made of whole milk, consisting of the night's milk mixed with that of the following morning. The night's milk is strained into the cheese vat as soon as it is drawn, and then cooled down to as low a temperature as can be conveniently reached by the aid of the ordinary cold-water supply, stirring being continued at intervals in order to hinder the cream from rising to the surface. Such cream as has found its way to the surface by the following morning is skimmed off and placed in a pan ready for mixing with twice its bulk of warm morning's milk, which has the effect of softening it so that it will readily pass through the strainer and mix again with the milk in the vat. To ensure a proper degree of ripeness in the milk before adding the rennet, the best makers use a small amount of 'starter', the quantity varying from $\frac{1}{4}$ to $\frac{1}{2}$ per cent. Other and less satisfactory methods are followed, such as using kept whey, &c.: but whatever ripening agent is used, it is as a rule added to the night's milk after skimming off the cream in the morning, and before straining the morning's milk into the vat.

Up to this stage the treatment of the milk is the same, whether quick-, medium-, or slow-ripening cheese is to be made, but from here onwards various slight modifications in the process followed occasion the difference in the products. By far the greatest proportion of the cheeses at the present time are made on the medium-ripening system. This process will now be described, and the modifications required for the other systems will afterwards be pointed out.

After mixing the evening's and morning's milk thoroughly in the vat, colouring matter, annatto if required, is added at the rate of 1 dr. to every 4 to 6 gal., and the temperature is gradually raised to 84° to 86° F., at which temperature it is renneted, but not until the milk has the proper degree of ripeness, which is shown when 1 dr. of milk will coagulate 4 oz. of milk in exactly 28 seconds. The amount of rennet used is $1\frac{1}{2}$ oz. to every 40 gal. of milk—equivalent to 1 dr. to 3 gal. After renneting, the milk is stirred for five minutes or so to prevent the cream from rising, and then covered, and left for from forty to sixty

minutes to coagulate. When the coagulum has reached the proper consistency, the surface is carefully turned over to the depth of about 1 in. by the aid of a sharp-edged skimmer, before cutting with ½-inch-spaced American knives. The cutting is not completed in one operation, but the curd is first cut lengthwise of the vat and then allowed to stand for five minutes. Afterwards the work is completed by cutting the curd twice lengthwise and twice crosswise. The curd is then allowed to rest for five minutes before commencing to stir for from 40 to 50 minutes. This stirring must be done very carefully, because the curd is very tender, especially in the early stages.

After stirring has been in progress for some ten minutes, the temperature is gradually brought up to 88° F., and after stirring has been completed the curd is allowed to pitch for from thirty to forty-five minutes, and is then drawn to the top of the vat before drawing off the whey. When the whey has run off, the curd is cut into 3- or 4-in. cubes and placed on a cloth on racks in the bottom of the vat. The acidity of the curd at the time of drawing the whey is not noticeable to the taste, and scarcely so to the smell, and is judged either by the amount of shrinkage which has taken place or by the hot-iron test, when it should just and only just begin to draw threads. The curd, after being placed on the racks, is kept there for about an hour; during that time it is cut thrice, at intervals of fifteen to twenty minutes, into 4-in. cubes. The curd is covered only by the ends of the cloth in which it is placed, and not weighted in any way.

The next stage is grinding or milling, as it is sometimes called. The suitability of the condition of the curd for this process is, as a rule, judged by the extent to which it has shrunk, and by its cleavage. It has at this time a distinctly acid smell, but is not acid to the taste. Before actually milling, the curd is broken by hand into pieces about the size of large eggs, and spread out on the cloth for a few minutes. The grinding is done by passing it through a close-set mill. Provided the temperature of the milled curd is not more than 80° F. it is immediately salted, at the rate of 7 oz. salt to every 20 lb., and put into the chesset. The chessets used are usually from 12 to 15 in. in diameter, and of sufficient depth to turn out cheeses weighing from 40 to 80 lb. each. After being put in the chesset, the cheese, as it may now be called, is kept in a cheese oven at 75° F. for forty-eight hours, being turned into a dry cloth each morning and evening, no pressure being meanwhile applied. After leaving the cheese oven the cheese is pressed for four or five days, or until it ceases to exude moisture while under pressure.

The ripening process occupies from six to twelve weeks, and the best results are obtained by turning the cheese daily, and by keeping it in a room on the ground floor at an even temperature of 55° F.

This is a description in detail of the process of making a medium-ripening Cheshire. The following table will explain the modifications which it is necessary to adopt in order to produce cheeses of the quick- or slow-ripening types:—

Steps in the Process.	Early Ripening.	Medium Ripening.	Slow Ripening.
Care of the night's and morning's milk	The same as already described for medium ripening.		
Amount of 'starter' added ...	About ½ per cent.	About ¼ per cent.	About ¼ per cent.
Rennet test	24 sec.	28 sec.	28 sec.
Temperature at which rennet is added	84° to 86° F.	The same.	84° to 88° F.
Amount of rennet used ...	2 oz. to 40 gal.	1½ oz. to 40 gal.	1 oz. to 40 gal.
Size to which it is cut	About ¾-in. cubes.	About ½-in. cubes.	About ⅜-in. cubes.
Length of time stirred in whey	30 to 40 min.	40 to 50 min.	40 to 50 min.
Temperature to which heated in whey	84° to 86° F.	88° F.	90° F.
Length of time curd allowed to settle (pitch) in whey ...	40 to 60 min.	30 to 45 min.	30 to 45 min.
Hot-iron test when whey is drawn	Thread ¼ in. long.	Only just commencing to draw.	Only just commencing to draw.
Treatment on racks when draining	Turn every 15 min. and cut into 6-in. cubes each time.	Turn every 15 min. and cut into 4-in. cubes each time.	Same as medium keeping.
Hot-iron test when ready for milling	Threads 1 in. to 1¼ in. long.	Thread about ½ in. long, but judged more by shrinkage.	Threads less than ½ in. long, judged more by shrinkage.
Amount of salt to every 20 lb. curd	6 oz.	7 oz.	8 oz.
Length of time in cheese oven...	24 hours.	48 hours.	48 hours.
After treatment	The same in all cases as described in text.		
Length of time to ripen ...	2 to 6 weeks.	6 to 12 weeks.	3 to 12 months.

[J. F. B.]

Cheshire Pigs.—Like so many of our local types of pigs, those kept in Cheshire have disappeared before the railway and improved farming. It was a long-legged and flat-sided white pig with coarse hair and strong bone, but has been wellnigh crossed out of existence. By crossing with the Large White Yorkshire its feeding properties and the quality of pork have been improved without any reduction in the fecundity and free milking gifts of the

sows. Some fifty or more years since, some of these west-country pigs were exported to the United States, where they are still known as Chester Whites. [S. S.]

Chesset. See DAIRY APPLIANCES.

Chest, a cavity in the upper part of the body of a vertebrate formed by the ribs, the backbone, and the sternum. The chest contains the heart, lungs, and part of the trachea.

Chester Whites. See CHESHIRE PIGS.

Chestnut, The Horse- (*Æsculus Hippocastanum*).—Though similar in name, this tree is very different from the Chestnut proper, that is the Spanish or Sweet Chestnut. It is a large tree, indigenous chiefly throughout the mountains of Greece and Asia Minor at an elevation of 3000 to 4500 ft., and was introduced into Britain in 1550 or about 1629. Its specific name is derived from the fact that the seed of this tree was used by the Greeks and Turks for curing glanders and pulmonary diseases in horses. The genus Æsculus of the Hippocastanaceæ or Horse-chestnut family is widely spread throughout Europe, Asia, and America, but the Common Horse-chestnut is the only species that is largely cultivated in Britain for avenues and town-planting, although two smaller American kinds, the Yellow and the Purple Buckeye (*Æ. flava* and *rubra*, sometimes reckoned a separate genus, Pavia), are frequently grown for ornament in parks and gardens, as also the Red Horse-chestnut (*Æ. carnea*), a hybrid between the common species and the Purple Buckeye, with leaves like the former and flowers resembling the latter. While the family characteristics of the Hippocastanaceæ are their palmately compound opposite leaves, their showy, irregular flowers, their three-chambered ovary, and their capsular fruits opening spontaneously by three valves, the genus Æsculus is specialized by having a campanulate calyx, four or five expanded petals with an ovate border, stamens with inwardly recurving filaments, spiny capsules and rough-stalked leaflets (though the capsules and the leaflets of the Buckeye are smooth); while the Common Horse-chestnut is distinguishable by having usually seven sessile or very shortly stalked leaflets (the Buckeye having usually only five distinctly stalked leaflets), erect conical clusters of white flowers internally tinged with pinkish-red, which appear profusely in May, and glossy dark-brown fruits that ripen in October. On its trunk the longitudinal bark fissures often run spirally. It is sometimes planted in copsewoods, but its white wood is soft and neither strong nor durable as timber, so that it is chiefly cultivated for its ornamental effect. It used to be largely planted in towns not having a very smoky atmosphere, but does best as an avenue and park tree, where its profuse flowering makes it a striking object in spring. One of the most famous of such avenues is that at Bushey Park, near London, which was planted 'in the Dutch style' by William III, and which is one of the sights of the spring season. In the isolated positions this tree usually occupies it attains a height of 50 to 60 ft., and a girth up to about 12 to 15 ft. It is hardy so far as regards climate, but its branches are easily broken by heavy winds. Its summer outline is somewhat hard and formal, though distinctly picturesque, for the very umbrageous oval-pyramidal crown often extends on the wide-spreading lower branches to near the ground. It is one of the earliest trees to show the autumn tint, when its thick mass of foliage assumes a light-brown russet hue. Its leafless winter condition is very distinctive, as all the heavy lower branches, after ascending at first at an angle of about 75° from the stem, incline downwards and then curve upwards again, like the arms of a candelabrum. But the tracery of its branchlets and twigs is singularly beautiful. It hardens its shoots very early in the season. They are, however, more liable than those of most other trees to be attacked by the red-coral fungus disease caused by *Nectria cinnabarina*, which quickly spreads round the twigs or branchlets, and whose scarlet pustules are conspicuous before these rot and break. Trees are easily raised from seed, which should be sown scar downwards and smooth side upwards about 4 in. apart in drills as soon as it ripens in October, and which should have a covering of over an inch of soil. If sown scar upwards, root malformation often results. The seedlings grow vigorously, and can be transplanted as yearlings into the nursery lines, to stand for another year or two till of the size wanted. To attain its full beauty as a park or avenue tree, it needs a good and dry loamy soil. [J. N.]

Chestnut, Sweet or Spanish (*Castanea vesca*), is, both on account of its edible fruit and its good timber and useful coppice, by far the most important species of the Chestnut genus (Castanea), which along with the Oak and the Beech forms the Fagaceæ family (formerly called Cupuliferæ), characterized by having each flower or group of flowers enclosed in an involucre of numerous bracts which coalesce and form a cupule round the fruit. Its closest relative is the Beech, from which it differs botanically—(1) in having its female flowers clustered at the base of the long spikelike male catkins, instead of in separate terminal bunches; (2) in its cupule being covered with long, thin, interwoven prickles, instead of short soft prickles; and (3) in its nuts being large and plano-convex, and not being three-cornered and sharp-pointed. But in all its outward appearance it is easily distinguishable from beech, oak, or any other of our forest trees, through its oblong-lanceolate, glabrous, serrately toothed leaves with numerous parallel side-nerves each ending in a very sharp point, which turn pale-yellow in early autumn; its thick grey-brown and deeply corrugated bark, whose longitudinal fissures often run spirally, and its somewhat pendulous lower boughs and branchlets, often candelabrum-like, as in the Horse-chestnut. Its generic botanical name is said to be derived from the city of Castanaia in Pontus (or Castana in Thessaly), where a large trade in the nuts existed from ancient times. But France and Italy now have the bulk of this trade, although in most districts throughout Southern Europe the nuts form an important and cheap article of food. The Chestnut is a widely spread tree, occurring

indigenously both in eastern and western Asia, on both sides of the Mediterranean, and also in the North American woods, and it was introduced into Britain by the Romans. Besides the common European kind, one Japanese and two North American species are known, only one of which is here grown for ornament, the Dwarf Chestnut (*C. pumila*), from the Southern States of North America. The Common Chestnut forms more or less extensive forests along the whole of Southern Europe, and in the warmer parts of Austria; but in Britain it is of true woodland growth only throughout the warmest localities, where it is, however, only found occasionally intermixed among the standard timber-trees in the copsewoods. But as coppice, now that the market for home-grown oak and other barks for tanning has diminished so much, chestnut is usually, next to ash and hazel, one of the best and most profitable kinds of underwood, and especially on light loamy and sandy soil. It has a strong reproductive power. It coppices freely, and also sometimes throws up suckers; and its saplings are sometimes 20 to 30 ft. high and 12 to 15 in. in girth at about eight to ten years of age. Hence it was in strong demand throughout the south of England when hop-poles were required, though this market is now also fast disappearing. In sheltered copsewoods or in high woods it soon gets drawn up into stout poles, which rapidly thicken in girth, though of course its growth is not so quick as in the warmer parts of France, where sixty-year-old trees often girth over 5 ft., or an average of 1 in. per annum.

Its light yellowish-brown and often prettily grained timber is tough and durable, and makes good parquetry and furniture, while as posts and poles used in the ground (*e.g.* hop-poles) it is one of the best woods to use. A new use of eight- to ten-year-old coppice-shoots is to split them into thin strips and bind them with wire to form the light, movable 'Peignon fencing' introduced recently from France; and they also yield good material for cask-hoops, hurdles, &c. But despite its rapid growth it is not largely grown as a standard in copsewoods, or along with other trees in highwoods. Having a strong, deep root-system, it needs a deep soil to thrive properly; but although bearing side-shade well it needs room for spreading laterally in order to thicken in girth, while its timber is often rendered valueless for boards, planks, &c., owing to ring-shakes in the heartwood. In parks and on lawns, however, it is a highly ornamental and graceful though massive tree, often developing enormously large limbs. The most famous of the English Chestnut trees is that which grew at Tortworth (Gloucestershire, Earl Ducie's seat), which was said to have girthed 44 ft. in 1791, and to have dated from about the year 700 A.D., and which was still bearing fruit in 1844. Probably the largest now to be found in the United Kingdom is one growing at Rossanagh Park (Co. Wicklow, Col. Tighe's estate), which in 1903 girthed 33 ft. at 3 ft. up, and 28 ft. 3 in. at 5 ft., and whose three main branches girthed 13 ft. 3½ in., 13 ft., and 10 ft. 7½ in. respectively.

The Chestnut fruits freely in the open from about twenty to thirty years of age onwards, and less freely or frequently in close woods from about fifty to sixty years on; but the fruits are here usually small in size and often incompletely ripened. Hence it should be grown from the foreign fruits so easily obtainable. The nuts should be sown in spring point downwards, and covered with 1½ to 2 in. of soil. If sown at 3 to 4 in. in drills about 1 ft. apart, the quick-growing seedlings can be planted out at two or at three years of age, spring planting being often best where late frost is frequent.

[J. N.]

Chestnut Colour. See COLOUR OF ANIMALS.

Cheviot Sheep.—The two great breeds of mountain sheep in Scotland are the Cheviot and Blackfaced. Each breed has its enthusiastic supporters, who warmly claim great advantages for their favourites. With all such claims and counterclaims we are not at present concerned. This only need be said, that for hardiness and utility the Cheviot sheep has a value all its own. The early history of the Cheviot is uncertain—the great breeders of the past being more concerned to make history than to write it—but very many of the present generation would have been glad to have had some record of the experiences—the failures and the successes—that attended the efforts of those who spent long years in developing the characteristics which have made the Whitefaced breed of Scotch sheep favourites over a considerable part of the globe.

The breed takes its name from the range of hills which extend along the border of Northumberland and Roxburghshire. Low says (Domestic Animals, p. 93): 'The true Cheviot district is limited in extent, and differs greatly in its character from the heathy wastes adjoining. It is composed of a range of beautiful mountains tending to the conical, and mostly covered with grasses, ferns, and wild thyme often to the very summit.' These hills are peculiarly fitted for the development of the best characteristics of the sheep which have there their home.

In the year 1791 the British Wool Society was established by Sir John Sinclair and a number of noblemen and others, who were interested in the improvement of the quality of the wool produced in Scotland. Several delegates were appointed to visit the principal sheep districts of Great Britain, and to examine and report on the different breeds they might come across. During these investigations a breed was discovered on the borders of England and Scotland which Sir John considered well suited for being bred and reared in other parts, and especially in Highland districts. They were whitefaced, and from their length were called the 'long' sheep, in contradistinction to the 'short' or Blackfaced breed. To these sheep Sir John gave the name of the Cheviot breed (Transactions of the Highland and Agricultural Society, 1880, p. 114). How long the breed had existed, or how it had come into existence at all, it is impossible to say. Youatt, writing in 1837, says: 'On the upper part of that hill in Northumberland which is properly termed "the Cheviot",

a peculiar and most valuable breed of sheep is found. They have been there almost from time immemorial. Tradition says that they came from the border district of Scotland, but they are totally different from the Blackfaced sheep, and bear little or no resemblance to the original dun-faced Scottish stock. How two breeds so totally different from each other came to inhabit the neighbouring districts of Ettrick Forest and the Cheviot Hills neither history nor tradition has attempted to explain' (Youatt on the Sheep, p. 284). In the first volume of the Cheviot Flock Book (p. x) it is also asserted that the Cheviot sheep 'have been bred and kept on their native hills from time immemorial'. And they are mentioned in a writing so far back as 1470 as the 'sheep of the Cheviot hills called the "long" sheep'.

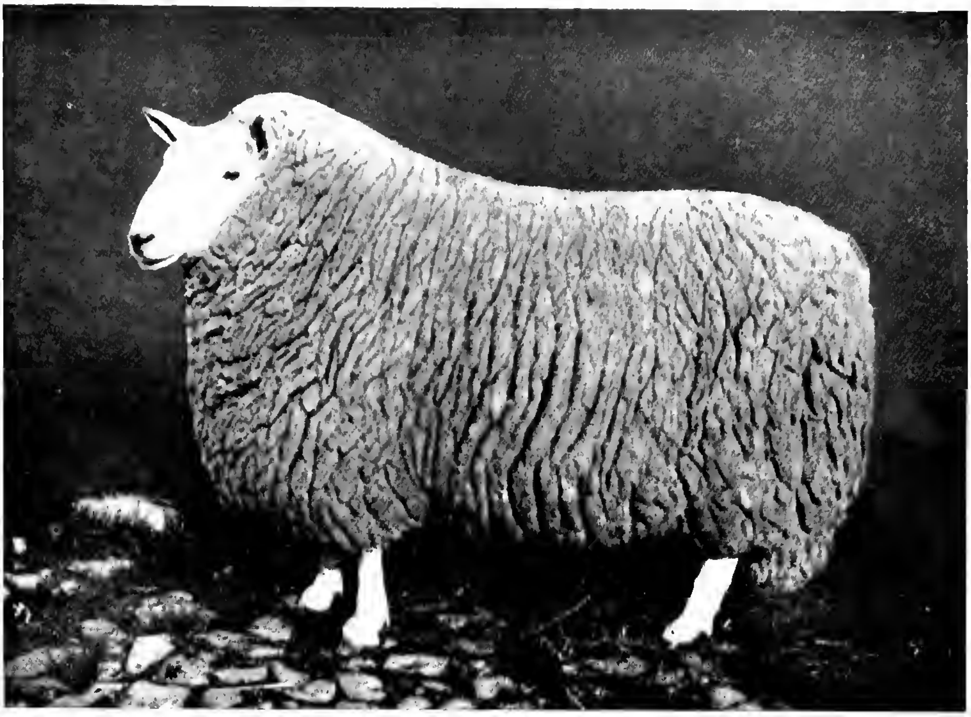
Prior to the union of Scotland and England in 1707, the border district was the scene of incessant raids and disturbances, which would make continuous or consistent breeding impossible; but forty or fifty years later, it is said, Mr. Robson of Belford, a Roxburghshire farmer, made a fair start towards the development of the present variety of sheep (Transactions of the Highland and Agricultural Society, vol. xii, p. 112). It is not at all clear what steps Mr. Robson took. In fact, contradictory statements on the subject are made freely, some asserting that he used Leicester rams, others Lincoln. Doubtless rams of these breeds have been used for crossing with the Cheviots for a long time, but in the main Cheviots would be improved by selection of the most suitable types by careful breeders, and the breed itself kept pure.

In the later decades of the 18th century we get on surer ground, and there is no doubt that many farmers to the north of the border began to fetch rams from the Cheviot hills to cross with the sheep then on their holdings, which were generally of the Teviotdale or Blackfaced breed. The records of the experiments made by enterprising farmers, with a view to improve the size of their sheep and quality of their wool, are exceedingly interesting, but they are scanty. One old chronicler, writing of the parish of Oxnam, Roxburghshire, in 1794 (Statistical Account of Scotland), says: 'On the upper end of this and neighbouring parishes bordering on Northumberland, the sheep have been greatly improved of late, in shape, in weight, and quality of wool. This has been effected partly by farmers purchasing tups from Northumberland and other counties in England, or by purchasing from or exchanging with each other, and partly by adopting a different mode of breeding their tups. The farmers of the last generation took their tup lambs out of the whole flock, whereas now they select a few of their best ewes and such as have the finest fleeces, which they keep apart from the rest of the flock, with a good, fine-woolled tup procured as above, and out of the lambs bred from these they choose their tup lambs.' From this and similar notes we have come across it is evident that, as there were brave men before Agamemnon, there were careful breeders before the Brydons or the Elliots.

As has been indicated, it was with a view to improve the quantity of mutton, but more especially the quality of the wool, which was beginning to be in strong demand, that the Cheviot ram was so much sought after. In an early record of the parish of Yarrow (Rev. R. Russel in Statistical Account of Scotland, 1793) we find the following: 'The wool is of various qualities. In the lower part of the parish it is of considerably fine texture, and sells at 9*d.* per lb. In the upper part it is very coarse, and sells at 3*d.* or 3½*d.* per lb. Of late years the system of rearing sheep has undergone a considerable alteration, particularly in the lower district of the parish. Induced by the higher prices of wool, the farmers in this quarter are gradually quitting the old species and introducing the Cheviot breed. For this purpose they are at great pains every season to procure tups of a fine quality, nor have their laudable efforts to improve their stock of sheep been unrewarded. Some have trebled their prices of wool, others have doubled it. These improvements are solely confined to the farms about and below the church. All above remain in their former unimproved state. Although convinced of the great advantage resulting from rearing the Cheviot species, yet the farmers are afraid to try the experiment, from the idea that their lambs could not sustain the spring colds and storms to which their farms are subject. Some, however, who have had experience in rearing the fine long-woolled sheep allege that they are not so delicate as many represent them, and that they would thrive very well in many places where a tenacious adherence to ancient maxims and customs have as yet prevented their introduction. This being the case, it is to be hoped that those storemasters who have hitherto been prevented from rearing the Cheviot breed by long-established habits and groundless fears, will soon surmount these, and concur with spirit and vigour in forwarding the staple commodity of the country, which tends both to promote the prosperity of the nation and advance the interests of the individual.'

Farmers all along the borders were trying the same or similar plans to improve their sheep. So early as 1787 Mr. David Irvine, farmer of Polmoodie, a high exposed farm in the Moffat district of Dumfriesshire, 'put Eskdale rams of the Whitefaced polled kind, the same with the Cheviot breed, to his ewes of the horned Blackfaced kind. He sold his wool in 1790 at 10*s.* the six fleeces as against 6*s.* 3*d.* obtained for seven fleeces of the Blackfaces off the same pasture.' At that time, however, Mr. Irvine's ideas did not commend themselves to his neighbours; but the writer above quoted says in a note (Statistical Account of Scotland, 1793): 'There is no doubt that the fine, close, short-woolled breed of sheep is the proper sort for a hilly country, and that the wool may be brought, even on the Moffat hills, to 1*s.* 3*d.*, nay, perhaps even to 1*s.* 8*d.* per lb.'.

Introduced as they were, it is easily understood how the Cheviots of the earlier part of the 19th century, especially perhaps in the western districts of the south of Scotland, were somewhat irregular in appearance. Some were polled, some had horns. Some had fine skins, some



CHEVIOT RAM—"BATTLEFIELD"

3RD AT H. & A.S. SHOW, 1907; 1ST AND CHAMPION, NORTHUMBERLAND, DUMFRIES, ETC.

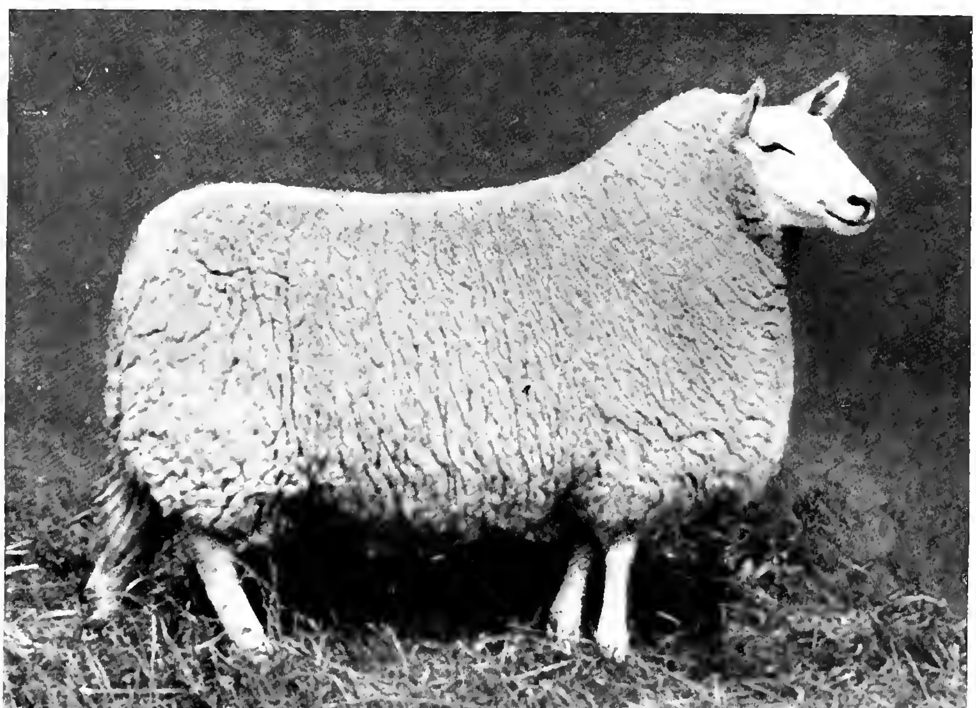


Photo A. M'Gregor.

CHEVIOT GIMMER

1ST PRIZE WINNER AT H. & A.S. SHOW, 1907

coarse. Some were big, some were little. Some had white faces, some yellow. In fact, what were known as Cheviots were in many cases little other than crosses. To improve the breed, from about 1850 several enterprising flockmasters devoted years of their lives; but the most famous, as he was the best known, was James Brydon (see art. BRYDON, JAMES). The type of sheep sought by Mr. Brydon was large and stylish, and his kind were bought by almost every owner of a Cheviot flock throughout Scotland. However, the testing time came with some bad seasons, such as 1879, and the losses among Cheviot sheep were disastrous. As Professor Wallace, in his excellent account of the Cheviot breed, says (Farm Live Stock of Great Britain, p. 528): 'In attaining size and beauty, Brydon had got on the wrong tack, and had sacrificed hardihood and utility, the two essentials in a mountain sheep, for sale-ring appearance'. The result has been that a great many farms in the south of Scotland have in recent times had their stock changed, and Blackfaces have taken the place of Cheviots. Notably, the greater part of the land farmed by Mr. Brydon himself carries Blackfaced stock.

In 1792 Cheviot sheep were introduced to the north of Scotland by Sir John Sinclair: many small holdings disappeared in the course of a few years to make room for the incomers, and the number of sheep increased to a remarkable extent in Caithness, Sutherland, and other northern counties in the first and second decades of the last century. The reaction in favour of the Blackfaces, which of late years has been so marked in the south and south-west of Scotland, has not occurred in the north, and except in cases where the land was wanted for planting purposes, the Cheviots have not been required to give way to any extent. The grazings along the north coast are well suited to the breed, but the success with which Cheviots have been reared in the north is no doubt due to the favourable climate, influenced as it is by the Gulf Stream. However it has come about, the north sheep have attained a great size and a fine quality of wool. Generally speaking they have not the smart stylish appearance of the sheep of the south, but for taking to heavy good land for crossing purposes, Sutherland and Caithness ewes are preferred to those of any other quarter. Mr. M'Dowall of Girstingwood, Kirkcudbright, who has bred and fed the champion Cheviot wethers at Smithfield fat show for a number of years, uses both tups and ewes from the Highlands.

It is impossible to calculate the numbers of Cheviot sheep in the country. The recently published Report on the Production of Wool in Great Britain gives some interesting statistics; but, after all, these are founded on the estimates of various correspondents who have no means of exact information. The statistics furnished by wool buyers are in no way reliable as indicating the numbers of the breed in existence in any particular year, as flockmasters have been known to hold their clips over; so that even if every wool buyer in the country reported every fleece he had bought, the statistics would not be entirely to be depended n. Probably from about the beginning of the century till 1870 the breed increased—at first rapidly, latterly more slowly; but from about 1880, or perhaps a few years earlier, till the end of the century the numbers decreased, and many farmers changed Cheviots for Blackfaces. The arguments for this course were, that the Blackfaces were hardier than the Cheviots had become; that more of them could be kept on the same land; and that, owing to the fall in the price of Cheviot wool, there was not much loss in the one case compared with the other. Besides, as the Blackfaced sheep were in demand for crossing purposes, the ewe lambs that could be spared for sale always found a ready market at very remunerative prices. The tendency to change has, however, been of late years checked: some say because all the farms suitable for Blackfaces have now been put under Blackfaces; others say because the change has not been found so profitable as was expected. One fact for which it is difficult to account is curious. For the first few years after the change was made, the Blackfaced ewes were exceedingly prolific and a handsome return was secured by the flockmaster. In the course of a few years, however, things gradually fell away, and the golden age for the farmer had evidently not yet come. The price of Cheviot wool has during the past three or four years been much higher, Cheviot ewes are in strong demand for breeding half-bred lambs, and what ewe lambs can be spared are much more easily sold now than a few years ago. In the face of these altered and much-improved conditions, it is probable that not a few who have changed would be glad to have the Whitefaces back again to their old haunts. At present Cheviots are mostly bred in Roxburghshire, Dumfriesshire, the eastern part of Kirkcudbrightshire, Peeblesshire, Selkirkshire, Sutherland and Caithness, and Northumberland. But in addition there are considerable numbers of the breed in Argyllshire, Ross-shire, Lanarkshire, Perthshire, Inverness-shire, on the Lammermoor hills, and in the Isle of Skye.

The Cheviot breed has found its way into many lands. Of late years both males and females have been sent from Scotland to South Africa, New Zealand, the Falkland Islands, the Argentine, Norway, Sweden, and America, and in almost every case they have proved successful. It is many years since the breed was first tried in Canada and the United States, Mr. Pope of Quebec having introduced it about 1825 to Canada, and Mr. Young of Delaware Co. in 1838 to the United States. Although a considerable number of farmers in the States have a few Cheviots, there are no flocks of any great size. This conclusion can safely be drawn from the following statement by Professor Plumb: 'During the past summer Mr. Keim made a trip to New York State and purchased a carload of Cheviots, so that on January 1, 1900, his flock of pure-bred sheep numbered about 175 head, and this, so far as I can learn, is much the highest in the United States'. The same authority says there are probably not more than 125 pure-bred flocks in America.

The original Cheviot—the first mention of which as the 'long' sheep is in 1470—was a very different kind of animal from what we now know. He is said to have been comparatively small and scraggy in frame, light in bone, with brownish-coloured head and legs. The so-called improved Cheviots of the third quarter of the last century were much larger, and the best specimens of Mr. Brydon's breeding were as handsome animals as one could desire to see. However, in the attempt to develop show and sale-ring qualities, inbreeding and high feeding were resorted to to a considerable extent, and these practices in time worked havoc. Professor Wallace says: 'The sheep bred from Mr. Brydon's rams grew long and lanky, and the coats were open and watery, and worst of all, the ewes became very lean in winter, developed into bad milkers, and in consequence deserted their offspring, which, being naturally soft, made a very short struggle for existence. With all their bad qualities they were very prolific, as many as from one-half to two-thirds of the ewes on good hefts producing twins, half of which had to be killed in bad seasons.' Possibly, however, this is putting the case rather strongly, as shepherds who experienced 1879—probably the worst year in the memory of any still working—say that while there were more lambs than the ewes could nurse, many of the superfluous little ones were otherwise disposed of than by the summary method indicated by Professor Wallace.

The Cheviot of the present day is in many respects different from that of Mr. Brydon's time, a smaller and hardier type of animal being preferred. Flockmasters, after experiencing the losses of the 'seventies and early 'eighties, where they did not change breeds altogether, secured rams with short sides and legs and close coats, not objecting in some cases to a little hair in the coat as a supposed sign of hardiness. The result has been that the breed has come to be recognized once more as hardy and welldoing, although there has been a general sacrifice of size. It is, however, somewhat unfortunate that big sheep came to be regarded as soft, and small sheep the reverse, as there is no necessary connection between size and constitution. During the past few years a tendency to increase the size of the sheep has again become apparent, and it is very noticeable at the tup sales that the best demand prevails for the bigger class of rams with the strongest bones. The modern sheep is described in Volume I of the Flock Book, 1892. He, it is said, should have a lively carriage, bright eyes, and plenty of action. His head, of medium length, and broad between the eyes, should be well covered with short, fine white hair. His ears, not too long, nor too near each other, should rise erect from the head, and like the head should be well haired. His nose and nostrils should be black, full, and wide open; his neck should be strong and not too lengthy; his breast broad, and his legs set apart. His ribs must be well sprung, and a long, weak back is about the worst fault a Cheviot can have. The back must be broad, and well covered with mutton, the hind quarters full, straight, and square; the tail well hung and nicely fringed with wool. His legs must stand squarely from the body, hocks pointed in being a decided weakness. The bones of his legs should be strong, broad, and flat, and all covered with short, hard white hair. He ought to grow a fleece of moderately long and fairly fine white wool, densely planted, of equal quality, and covering the whole body, above and below, and well down to the knees and hocks. A break in the wool at the throat or cheeks or behind the ears is seriously objected to, and bareness of the breast or belly is a decided blemish. A Cheviot ram at maturity will weigh 200 lb. live weight, and will clip 8 to 10 lb. of wool. A cast ewe when fed will provide 15 to 18 lb. of mutton per quarter, and wedders 18 to 20 lb., although in cases where special treatment is given, much greater weight can be reached. For example, Mr. M'Dowall of Girstingwood gained the championship at the Scottish National Fat Club Show in 1905 with three Cheviot wethers twenty months old, whose combined live weight amounted to 855 lb. Mr. M'Dowall, who has a very large experience in feeding different varieties of sheep, and who has taken for many years a leading place both at the Scottish National and Smithfield shows, considers the Cheviots the most valuable of our Scottish breeds of sheep. He has had wedders at twenty months old scaling over 300 lb., and lambs about ten months weighing 170 lb. live weight. He has won the championship of long-woolled breeds of British sheep at Smithfield with Cheviots. These take always a high place at the great carcass competition which is annually held in connection with the above show, and that their mutton is of superior quality is proved by the price it commands in the market.

On a Cheviot farm, one of the most considerable items is the wool, and a flockmaster's year is successful or the reverse according to the price he gets for the fleeces of his flock; and here it may be stated that ewes in average condition should clip 4 to 4½ lb. of wool each, the hoggs, if well wintered, slightly more. For the last ninety years a careful record has been kept of the prices got both for wool and sheep, and these are to be found in the Transactions of the Highland and Agricultural Society. The lowest recorded prices for Cheviot wool were paid in 1901 and 1902, when unwashed clips sold at from 4½*d.* to 5*d.* per lb., and washed from 5½*d.* to 8¼*d.*, according to quality. On the other hand, in 1872 prices touched a figure which in these days seems past hoping for, namely, for unwashed samples, 1*s.* 1*d.* to 1*s.* 6¾*d.* per lb., and for washed, 1*s.* 8*d.* to 2*s.* per lb. So it came to pass that the anticipation of the writer who chronicled the experiments of Mr. David Irvine of Polmoodie in the later years of the 18th century were fully realized. The variations in the prices obtained for sheep and lambs are equally astonishing. The lowest recorded prices all round were taken in 1822, when they were, for Cheviot wedders (three years old), 12*s.* 6*d.* to 13*s.*; for ewes, 8*s.* to 8*s.* 6*d.*, and for lambs 4*s.* 6*d.* The highest prices, on the other hand, were touched—for wethers in 1872, 45*s.* to 56*s.*; for

ewes in 1883, 34*s.* 6*d.* to 46*s.* 6*d.*; and for lambs in 1866, 15*s.* to 26*s.*

Rents of sheep farms vary considerably in various districts of the country. For the most part the farms are large enough to carry thirty-five to sixty scores, but in some cases they are much larger, in many they are much less. Between 1870 and 1880 the rents rose, until it was quite common for the farmer to pay at the rate of from 10*s.* to 12*s.* per sheep. Since 1880 the rents have continued to fall until 1906, when the downward tendency seemed to have got a check. At present, 5*s.* to 7*s.* 6*d.* may be stated roughly as the rate per sheep paid to the landlord of hill grazings.

As every merchant has his own method of conducting business, so each flockmaster has his own scheme of operations throughout the year; but in the main a general plan is followed in the districts where one breed abounds. In the west all the different ages of sheep run together over the whole farm, while on the east border a common practice is to keep the hoggs and eild gimmers on a hill by themselves. Each plan has its advantages and disadvantages.

In giving a short account of the management of a Cheviot stock, it will be convenient to take Martinmas as the date for starting. With practical unanimity farmers put the rams to the ewes on 22nd November. For every fifty-five or sixty ewes one tup is provided. And shepherds go their rounds with great regularity during the six weeks when the rams are out. At New Year's Day they are taken in, and those which are not to be used another season are sold for what they will bring, possibly 15*s.* to 20*s.* each. This saves their wintering, and in many cases when they are held over till the following summer very little more is got for them.

During January, February, and March it all depends on the weather whether the shepherd's lot is a happy one or the reverse, but with the advent of April his busy time comes on. The hoggs that have been wintered away have to be brought home, and his potato patch has to be ploughed and planted. Lambing will commence on 17th or 18th. Extra hands have to be engaged, for in few cases should a man have more than eighteen to twenty scores to look after during this season, whereas he may quite easily have thirty to thirty-five scores all the rest of the year. Lambing assistants are got for three or four weeks, who receive high wages: £6 to £7 with board being quite commonly asked for four weeks. It is difficult to say what would be an average crop of lambs. In the eastern districts, where a great proportion of the gimmers run eild, it is quite common to have twenty to twenty-one lambs to the score of ewes; but in the west nineteen lambs to the score is considered very satisfactory, and in many seasons seventeen to eighteen will be an average crop.

The 'marking' of the lambs, that is when their tails are 'docked' and the males castrated, takes place in June. During the same month the hoggs and eild sheep are clipped, but the ewes are not ready as a rule till the second week in July. Where the practice of washing the sheep is followed, clipping takes place six to eight days thereafter.

All sheep have now to be dipped twice each year, and the first dipping must take place not later than the first week of August. Both ewes and lambs are immersed in the bath. By the third week in August the lambs are 'speaned' or 'weaned', when the wethers and small ewe lambs are sent to market, the best ewe lambs to the number of about a fifth of the total sheep on the farm being kept for stock. In the east, after having the 'stock' and 'age' marks put on their ears, the keeping ewe lambs are put on grazing called the 'summering' ground; but in the west, after having been kept separate from their mothers for six or eight days, they are turned out on the hill again.

In former years many Cheviot wether lambs were required for the Highlands, where they were kept till they were three years old. Now, however, a great proportion of them go south; Hawick, Annan, and Lockerbie being centres from which thousands are sold annually for English graziers. Few lambs, in these days of early maturity, survive till they are more than eighteen or twenty months old. Second ewe lambs are purchased to be taken to lower or partly arable farms, where in due time they are mated with Leicester or Wensleydale rams. The result of this is a Leicester cross or half-bred lamb (see HALF-BRED SHEEP).

The lambs having been disposed of for another season, the second dipping required by the Board of Agriculture's regulations may with advantage be given as soon as September has set in; the nearer the two dippings are to each other, the cleaner will the sheep be.

In late September or early October the cast or 'crock' ewes, and also any lean or ill-thriven sheep in the stock, are drawn off and marketed. In the west all six-year-old ewes are sold, and a proportion of the five-year-olds—probably about a half. In the east many ewes are sold a year earlier. There is a great demand for good hill ewes for low farms and for England, to which they are taken to breed half-bred lambs in another season. The principal sales of ewes by auction take place at Perth, Castle Douglas, Lockerbie, Rothbury, and Hawick, but numbers are also sold at the great annual 'Character' fair held at Inverness in July.

If the second dipping has not been done in September, it must not be delayed long after the beginning of October. By 1st November the stock lambs which are to be wintered away are despatched, generally to small arable and dairy farms of the class so common in Ayrshire. Prices of wintering have risen greatly, and have become a serious expense to the stockowner, 7*s.* 6*d.* to 8*s.*, according to locality, being now commonly paid for each sheep.

About the end of October the ewes left on the farm are 'keeled', that is, each sheep gets a distinct mark made on her with ruddle, or similar red substance, so that the shepherd can tell easily, and even at a distance, his own sheep, and any of his neighbours' which may happen to stray to his ground. The stock at the same time is carefully and particularly counted.

The practice throughout Scotland does not vary very much from the foregoing, except that on the east border there are still on a few farms wedder hirsels, to which the wedder lambs are taken instead of being sold. The ewes also in the east are not as a rule kept, as has been noted above, longer than five years, and a large proportion of the gimmers are allowed to run eild.

In the Highlands there are still a considerable number of wedders kept till they are two or three years old, and many sales of these take place at Inverness Fair. Until recently, also, 'smearing' in place of dipping was common throughout the northern counties. This was done by applying a mixture of tar and butter to the skin of the sheep. It was considered that by this process the animal was helped materially to withstand the winter storms, and that the disease of scab was kept in check. This trouble has been long prevalent in the Highlands, but little known in the south, unless when imported by the sheep consigned in the later months of each year for breeding or feeding purposes. Energetic steps taken by the Board of Agriculture, backed up by the goodwill of local authorities throughout Scotland, have reduced this evil till it seems almost at the vanishing point.

The death-rate among Cheviots, as among all classes of sheep, differs greatly on different farms and in different localities. When the rate does not exceed one to the score it is not considered bad, but for a number of years this limit will not have been nearly reached on most farms. It is quite common on holdings of thirty to forty scores to have less than a difference of twenty between the keeling count in November and the clipping count in the following July.

One of the most important duties of the sheep-farmer, which falls to be performed annually in September or October, is the selection of rams to be used during the coming season. Some there are who treat this as a light matter, and many animals only fit for the butcher are bought at the ram sales because of their low price—certainly for no good point they possess. Sooner or later, and sooner rather than later, this tells on the stock. *Ex nihilo nihil fit* is a true proverb so far as sheep-breeding is concerned. Every careful flockmaster considers well what points or qualities he desires to see developed, *e.g.* strength of bone, quality of wool, &c., and selects his rams accordingly; but care must be taken that in attaining one good point, another, perhaps an equally valuable one, is not lost. Most farmers rear a certain number of tup lambs for their own use, but in every case fresh blood should be, occasionally at the least, introduced to the flock. Many sheep-farmers buy a good tup, and mate him with thirty to fifty, or even more, selected ewes. From the lambs thus bred they choose the tup lambs, and consequently all the young rams to be used in a future season are half-brothers. One great advantage of this custom is that a family likeness is developed in the flock. Many of the best-known farmers, however, in the world of Cheviots make a trade of rearing and selling rams. The practice generally followed is to use the rams at home the first season, and sell them at one or other of the sales when they are two years old. The principal sales are at Hawick and Lockerbie, although a considerable number are also sold at Edinburgh and Dingwall. Mr. Brydon, Kinnelhead, and Mr. Borthwick, Hopsrigg, Eskdalemuir, were probably the earliest to develop the tup trade, and they had sales in alternate seasons at Beattock and Lockerbie, Dumfriesshire. For many years past, however, all the crack lots have been sold at Hawick by the Messrs. Oliver.

Tup breeders devote the greatest care to their work, and a high excellence has been attained by many specimens of the breed. From the time they are weaned, the ram lambs get every attention and the best feeding obtainable. The following season, that is when they are shearlings, they are only allowed a short time—seventeen to twenty days—with the ewes, and then carefully fed till the following autumn, when they are sold. For some weeks before the sale at which they are to be exposed, they are kept perfectly dry, that is they are put into a house or shed at night and on wet days. In order to get the best appearance the rams are, generally speaking, highly fed, and a considerable prejudice exists in many quarters against them, both on that account and because of the quantity of wool they are carrying; but when an unfed or barely clipped ram appears in the sale ring, only a very few will bid for him. In the work of shaping and dressing, and generally preparing sheep for show or sale, many shepherds have become adepts.

In February, 1891, a Cheviot sheep society was formed by those most interested in the breed, and a Flock Book was established, which is the recognized record of the pedigrees of Cheviot rams. Before 1891 each flockmaster kept the pedigrees, and published them in a private catalogue of the rams he had for sale. In the first volume of the Flock Book, some of the rams entered had pedigrees reaching back many years. For example, 'Awful Sandy' (No. 8), lambed in 1888, is traced back to 1849. 'Hotspur' (No. 87), lambed in 1890, is traced through many generations to 'Sellar', a ram sold to go north about 1805. The society keeps a register of rams, it being impracticable, owing to their number, to keep account of the ewes, 'but every ewe which is the dam of a registered tup must be the daughter, or granddaughter, of a registered sheep. In order to make the volumes less cumbrous, it is only compulsory for the sires of tup lambs to be entered in the Flock Book; though every tup used in the flock must, by being the son of a registered sire and descended from a ewe from a flock in which only pure-bred or eligible tups are used, be himself eligible for entry in the Flock Book'. This rule the society considers will secure purity of breeding (vol. i. p. ix).

Among those who have taken a leading part in the breeding of Cheviots after the time of Sir John Sinclair, Mr. Robson of Belford, Rox-

burghshire, and Mr. Jas. Brydon stand out pre-eminently. In later times, Mr. Thos. Elliot, Hindhope; Mr. Johnstone, Archbank, Moffat; Mr. Welsh, Ericstane, Moffat; Mr. Moffat, Craick, Hawick; Mr. Grieve, Skelfhill; Mr. Archibald of Glengelt, in the Lammermoors; and Mr. John Murray, Parkhall, Douglas, may be mentioned. At the present time the first place must undoubtedly be given to Mr. John Elliot, Hindhope, Jedburgh, who has had a phenomenally successful show and sale record.

The Messrs. Oliver, the well-known auctioneers of Hawick, have long taken a great interest in the Cheviot breed, and have had the honour of selling most of the noted tups. The highest price yet paid is £194, 5*s*., which was given by Mr. Millar, Scrabster, Caithness, at the Beattock sale in 1867, for 'Craigphadrig', one of Mr. Brydon's rams, which had been a winner at the Highland Society's Show in 1865. He has been described as a 'magnificent animal'. In that year (1867) Mr. Brydon's average was £8, 11*s*. 5*d*. for 174 animals. Two years previous (1865) he sold 169 sheep at an average price of £14, 14*s*., one ram making £155, another £121, and another £115. In the last few years the Messrs. Oliver have sold many fine rams at their Hawick sales, and satisfactory averages have been secured, although no sheep has reached the price of 'Craigphadrig'. In 1903 Mr. Thos. Elliot, Attonburn, obtained £18, 0*s*. 11*d*. for 22 animals, the highest price being £115, paid by Mr. Smith, Mowhaugh, for 'Ambush'. In 1904 Mr. John Elliot, Hindhope, exposed 30 tups, for which he got the average price of £18, 18*s*. 7*d*., £120 being paid for 'Lord Herries' by Mr. Elliot of Myrdyke and Singdean. In 1906 Mr. John Elliot again made the highest average of the season — £23, 18*s*. 8*d*. for 31 sheep, Mr. Scott Anderson of Ettrickshaws taking 'Carabine' at £100. In the season of 1907 Mr. Elliot 'bettered' his average once more, and secured £24, 6*s*. 4*d*. for 30, the highest price being £90, paid by Mr. Rea, Wooler, for 'Peebles Dandy', the Highland Society champion.

The following is an abstract of the accounts of a farm carrying forty-six score of ewes and twelve score of hoggs, two-thirds of which are wintered in Ayrshire. The rent is £300, and the capital invested is £2500. During a fifteen-year lease the lowest return was in the year from Whitsunday 1902 to Whitsunday 1903. The best was in the year Whitsunday 1906 to Whitsunday 1907. The accounts for these two years are appended:—

1902–1903.

RECEIPTS.

	£	s.	d.
Wool	92	2	0
375 wedder lambs	200	6	3
Ewe lambs	81	15	0
175 cast ewes	225	7	6
Shot ewes	12	14	3
2 fat ewes	3	0	0
Old rams	5	10	0
Skins	0	14	6
	621	9	6

EXPENSES.

	£	s.	d.
Rent	300	0	0
Interest	82	6	4
Wages	67	0	0
Shepherds' meal	8	10	0
Hoggs wintering	70	0	0
Rams bought	22	17	6
County and parish rate	6	4	5
Dip	6	0	0
Corn for tups, &c.	14	0	0
Sundry small accounts	7	3	0
	584	1	3

1906–1907.

RECEIPTS.

	£	s.	d.
Wool	210	15	6
Wedder lambs	256	17	0
Ewe lambs	117	13	0
175 ewes at 32*s*.	280	0	0
12 shot ewes	16	7	0
11 young ewes	12	13	0
Old rams	4	10	0
Skins	0	18	6
	899	14	0

EXPENSES.

	£	s.	d.
Rent	300	0	0
Interest	83	2	6
Hogg wintering	69	12	6
Wages	69	10	0
Rams bought	20	5	0
Parish and county rates	5	8	0
Corn for sheep, &c.	14	0	0
Dip	7	0	0
Shepherds' meal	8	0	0
Sundry small accounts	14	10	0
	591	8	0

[W. B.]

Chewing the Cud. See RUMINATION.

Chicken, Development of.—When a fertile egg is brought under the influence of a suitable degree of heat the germ starts into activity, and in order that the embryonic process may be completed this heat requires to be regularly maintained during the period of incubation. Should the temperature be increased or decreased for any considerable time the germ dies, and no further application of heat can restart it. The first period of incubation is commenced in the body of the hen directly fertilization takes place, after the yolk has broken away from the ovary and enters the funnel-shaped mouth of the oviduct, for the germ, commencing as a single cell, multiplies by segmentation. During the eighteen hours which are necessary for the formation of the remainder of the egg, this segmentation continues until the egg is laid. The germ of life in this state can be kept dormant for a considerable time, though undoubtedly a continuance at this stage diminishes the vitality.

During the first eighteen to twenty-four hours after the application of heat the embryo develops some of the most important organs, though rudimentary in form, among which are the head and the vitelline vein. At this stage, too, the amnion is formed, a membrane enveloping the embryo, and part of which forms

the amniotic sac. During the second day the head increases in size, developing much more rapidly than the rest of the body. On the second day also the first cerebral vesicle is formed, from whence the two optic nerves grow; behind the first cerebral vesicle two others make their appearance at this stage, and behind these again are two shallow pits, which afterwards develop into the organ of hearing. Between the thirty-sixth and the forty-eighth hour the blood begins to circulate, very, very slowly at first, but rapidly gaining strength. The heart also beats very slowly and irregularly at the beginning, but soon becomes more vigorous. The third day is perhaps the most important of all, several new organs making their appearance. The albumen by this time has decreased in quantity, a large portion having been absorbed in the formation and development of the chicken. The head begins to assume its normal shape, and the eyes, nostrils, and ears are well established. The organ of smell makes its appearance on the third day, besides which the lungs, liver, and kidneys also become visible.

The embryo has increased considerably by the fourth day, while the white has become correspondingly less. The limbs make their appearance at this period. Upon either the fourth, or early on the fifth day, a duct is formed, which in the case of the female is ultimately transformed into the oviduct, but as the male bird has no use for such an organ it remains rudimentary. It is not until this time that the future sex of a bird can be told, as up to this time the development of the two sexes is identically the same. The allantois—in reality a temporary network of bloodvessels—is formed on the fourth day, its purpose being to supply the blood with oxygen. On the fifth day the shape of the head can be easily distinguished, with exceptionally prominent eyes, and there is a further increase in size. The limbs can now be discerned quite plainly, though the wings and legs appear the same. Traces of the elbow and knee joints are noticeable at this stage. With the end of the sixth day there are further changes. It is at this time that the specialization of the bird becomes apparent. The body is now formed, but the head and eyes remain enormously out of proportion. The white has disappeared, its place having been taken by a thick brown liquid. On the sixth day, movements can generally be observed in the embryo. These are, however, very slight; it is not until the fourteenth day that the movements are at all vigorous. By the seventh day the body is practically complete, though out of proportion, and exceedingly small. On the eighth day the beak becomes visible.

The feathers generally make their appearance on the ninth day, and they are contained in sacs, in which they remain until after the chicken has made its exit from the shell. The increase in size between the seventh and ninth day is quite remarkable, as at the latter period the yolk has decreased in size. On the eleventh day the limbs have assumed their proper form, and upon the legs traces of scales are discernible. The most noticeable feature of the twelfth day is that heat commences to be given off by the embryo body, due to the activity of the bloodvessels. After the eleventh or twelfth day, as the various organs are fully formed, there is less danger of the embryo dying. By the thirteenth day the nails assume their form, and, together with the beak, have by the sixteenth day become quite hard. When the egg has been incubated for fifteen days the chicken is perfect, differing only in point of size from one that is fully developed.

The correct position for the fully formed chicken is with the head towards the broad end —the air space; if this position is reversed the chicken may have some difficulty in making its way out. Assuming that hatching is to take place on the twenty-first day, on the nineteenth the allantois is broken down and the chicken commences to breathe for the first time by means of its lungs. If the process of incubation has been successful, a fully formed, well-developed and healthy chicken should make its appearance on the twentieth or twenty-first day. Just before hatching, the chicken has absorbed into its body the remainder of the yolk sac, which henceforth forms part of the intestines. When the bird is ready to make its exit, the beak is turned towards the air space, which is pierced, thus giving the chicken more room. The shell is then chipped, and in a clean hatch this continues round the egg, usually following the line of the air space. As soon as the circle is nearly complete the chicken is able, by pressing its feet against one end of the egg and the head against the other, to force open the shell, thus freeing itself from its temporary home.

[W. BR.]

Chicken Rearing.—One of the most important questions which vexes poultry keepers is the excessive loss by death during the first three or four weeks of the chickens' lives, and it is well within the mark to say that in the United Kingdom the loss must amount to thousands of pounds every season. For the real solution of this question we believe that the subject must be regarded from a broader point of view, and that due attention should be paid to the stock which produces the eggs, and, equally important, the conditions under which the embryo chickens develop. This subject is discussed more fully under INCUBATION, but we may say here that poultry keepers should set themselves to hatch not merely as many chickens as possible from a given number of eggs, but that they should endeavour to bring out liveable youngsters. No matter what care and attention is bestowed on some chicks they cannot be reared to maturity; they receive their death warrant before they are hatched. Considering that the busiest time of the rearing season is in the early months of the year, and the variations in climatic conditions are both great and rapid, particular attention should be paid to the location of the rearing ground. The ideal spot is a paddock with a slight southern slope, sheltered on the north and east. A light loam on a porous subsoil is the best earth formation, as drainage is natural under such conditions. Such ideal situations

CHICKEN REARING: WINTER BROODER HOUSE AT THEALE, BERKS.

are almost impossible to find, therefore the defects must be remedied by artificial means.

Rearing is carried out under two systems—the natural and the artificial. When the number of birds to be reared is limited, the former is perhaps the more simple; but where hundreds of chickens are bred the artificial method is preferable, as it entails less labour and is quite equal in results. The appliances required for natural rearing are less expensive, but as labour is generally one of the most important items of expenditure, the initial outlay necessitated by the artificial system is made good in full.

In rearing with a hen, the mother and her brood, the latter numbering from a dozen in the early part of the year to fifteen later on, are placed into a coop. These coops are made in a variety of forms, but the two best are the single lean-to and the double. The single lean-to coop is made with a floor measurement of 24 in. by 24 in., 21 in. high in front, and 18 in. high at the back. The two ends, the back and the roof, are made solid of $\frac{3}{4}$-inch matchboarding (*i.e.* boards tongued and grooved); the front is fitted with bars of wood 2 in. wide and placed 2 in. apart. The centre bar is made movable to form a door. A wooden floor may be fitted for early work. The double coop has two compartments as its name indicates, and is constructed as follows: The floor measurement is 4 ft. by 21 in.; it is 21 in. high in front and 18 in. high at the back. It is divided into two compartments, the smaller being 21 in. long, and the larger 27 in. The two ends, the back and the top, are made solid of $\frac{3}{4}$-inch matchboarding, but the latter is made in two parts, and so fitted as to form lids. The front of the smaller, or sleeping section, is made in the form of a solid door. The partition and the front of the larger section, or scratching run, are both fitted with 2-inch bars, 2 in. apart, the centre one in each case being movable. Both compartments are fitted with loose wooden floors. The extra cost of the double coop is repaid by the many advantages it has over the single form. The chickens can be fed apart from the hen, a very desirable thing when expensive chicken foods are used; the larger section can be used as a scratching shed by the youngsters, and, moreover, in inclement weather it forms a sheltered run for them.

Brooding chickens by artificial means is a more important consideration than rearing under natural conditions, in that the heat which is applied must be given regularly and evenly. For early work, brooder houses are almost a necessity, but later in the season individual outdoor foster-mothers can be used. All foster-mothers can be divided into one of two classes, namely, those in which the heat is maintained by radiation from the lower surface of a tank of hot water, and those in which the ingoing air is heated before it enters. It may be stated generally that the former system is the better under all circumstances, in that the heat is maintained more evenly; but the latter are perhaps as good under normal climatic conditions, as a higher temperature can be obtained. There are two forms of hot-air brooders — one in which the

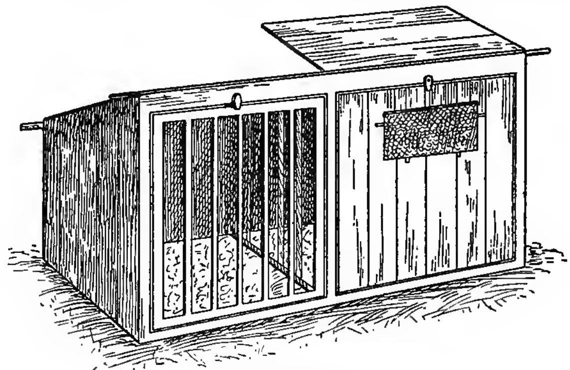


Fig. 1.—Double Coop

lamp itself is placed in the sleeping compartment, and the other in which the lamp is contained in a separate section of the brooder. The latter is preferable, as the fumes from burning paraffin oil are highly injurious, unless the combustion is perfect—an ideal which is never realized. The gases given off by burning petroleum are known to cause partial paralysis of the nervous system, therefore those rearers which are constructed so that the products of combustion are carried away to the outside air are obviously better. One great advantage

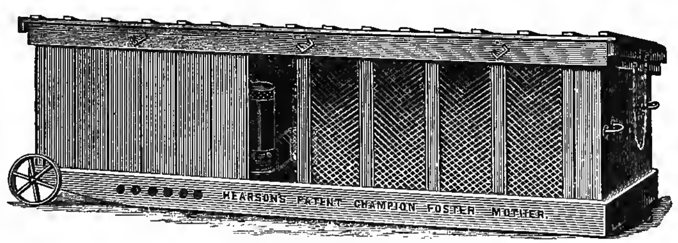


Fig. 2.—Hearson's Foster Mother

possessed by the brooders in which the lamps are placed in the sleeping compartment is that they are cheaper, but the money saved on the outlay may easily be lost later by the poorer results.

Specially constructed brooder houses are a necessity for winter rearing. These are large, lofty, well-built houses, divided into compartments, each one containing a brooder. The most convenient measurements are as follows: width, 12 ft.; height in front, $5\frac{1}{2}$ ft.; height at back, $6\frac{1}{2}$ ft.; height at gable, $7\frac{1}{2}$ ft. The gable is made 9 ft. from the front of the house. A wooden

floor covers the entire length, but a passage 3 ft. wide is allowed at the back. The length depends on the number of chickens to be accommodated, and this is calculated by making each compartment 5 ft. wide and putting 50 chickens

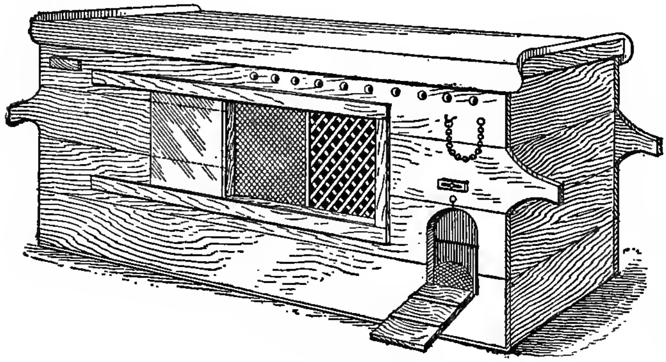


Fig. 3.—Miller's Brooder

into each, therefore a 30-ft. house will hold 300 birds. Large windows should be fitted in the front, and the shed should be efficiently ventilated.

Individual brooders, either of the hot-air or the tank type, are usually employed, but in some places—notably in America, and in a few instances in England — sectional brooders are

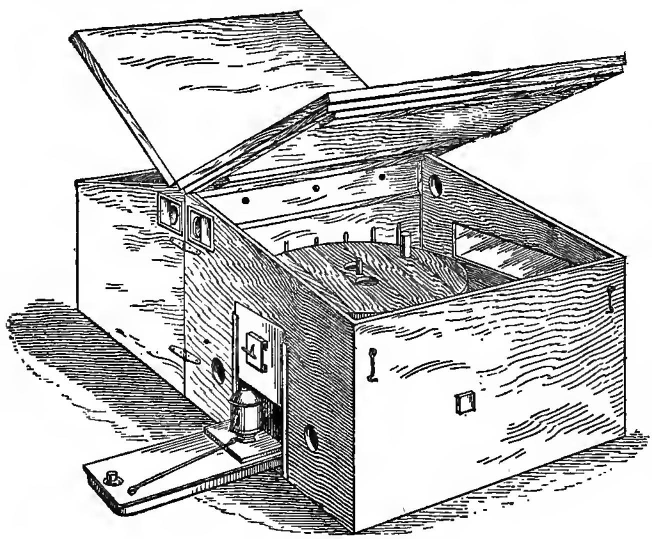


Fig. 4.—Brooder (Cyphers Co.)

used. These consist of a series of hot-water pipes—heated either by means of a lamp or a coke-stove — covered with wooden hovers. It has been found, however, that the use of individual brooders is to be advised, as they possess many advantages over the pipe system.

In artificial rearing, a very important factor towards success is the temperature at which the hottest part of the brooder is kept. For the first ten days this should not be allowed to fall below 90° F., and if five degrees above this no harm will be done. After ten days the temperature should be lowered by five degrees each week, until the chickens are old enough to do without artificial heat. It is found in practice that when a large brooder is used to its utmost capacity it is better to work at rather a higher temperature than when a smaller number are together. The reason for this is that there is always a tendency for them to crowd, and the additional heat hinders this.

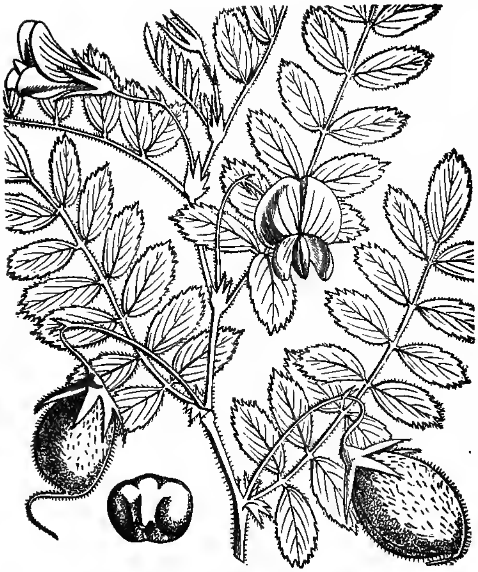
All brooders for use out-of-doors should be so made that there are three chambers, each with a different temperature. The hottest to be about 90° F., the second about 75° F., and the third slightly above the temperature of the outside air. Indoor brooders are only made with one compartment, as the brooder house itself will possess a fairly high temperature. The following points if carried out will assist in rearing: (1) Maintain an even temperature in the warmest section; (2) have the foster-mother so built that there is sufficient ventilation; and (3) do not overcrowd.

[W. Br.]

Chickling Vetch. See VETCHES.

Chick Pea (*Cicer arietinum*) is an annual of the leguminous order, covered with glandular hairs which secrete an acid fluid. It grows about a foot high, branches much, and has pinnated leaves, whose oblong leaflets, in about seven pairs and a half, are finely and regularly serrated from near the middle to the end. The flowers grow singly on slender stalks, and are white, tinged with pink. These are succeeded by oblong, turgid, hairy pods, terminated by a long style, and usually containing two pale-yellow seeds, having much the appearance of a ram's head. This little annual is a native of the south of Europe and many parts of the East. In India it is commonly cultivated, and it is one of the many plants known under the name of *gram*. Our summers are hardly long and warm enough to ripen its seeds.

In the south of Europe the plant is largely grown for the sake of its seeds, which are much employed in French cookery under the name of *Pois chiche*, or *Garvance*, whence the common



Chick Pea (*Cicer arietinum*)

name of Caravances. Gathered when quite ripe, they form the basis of the French soup called *purée aux croutons*. [J. L.] [A. N. M'A.]

Chickweed (*Stellaria media*) is a white-flowered annual plant abounding everywhere in

Chickweed (*Stellaria media*)

1, Petal. 2, Ovary. 3, Fruit (dehiscent).

ill-cultivated or neglected places. It belongs to the nat. ord. Caryophyllaceæ, which comprises also carnations, pinks, campions, the corn cockle, &c. In this nat. ord. the genus Stellaria is readily known (1) by its calyx consisting of five separate sepals; (2) by its white petals being slit nearly to the base; and (3) by having ten stamens, three stigmas, and a globular capsule which splits when ripe into six teeth or valves. The Chickweed has prostrate stems, *with a line of hairs passing down one side only*, and ovate leaves. This plant is a troublesome but not very formidable weed, difficult to get rid of, in consequence of the innumerable seeds which it brings to maturity in all weather when the thermometer is above 32° F., and also of its beginning to bear when only a few weeks old. It can only be extirpated by constant and careful tillage.

Mouse-ear Chickweed (Cerastium) is another white-flowered annual weed belonging to the nat. ord. Caryophyllaceæ. It is easily distinguished by being hairy all over, and by having a capsule or seed box in the form of a bent cylinder, not a little globe as in the common chickweed. Common chickweed affects rich land, but the Mouse-ear flourishes on poor dry sands, that is to say, it is a xerophyte. [J. L.] [A. N. M'A.]

Chicory, a perennial herb (*Cichorium Intybus*) belonging to the Composite family, and

Chicory (*Cichorium Intybus*)

growing 2 to 5 ft. high. Its bright-blue flower-heads make it very conspicuous in waste places. Chicory is commonly thought of as an adulterant of coffee, but it is extensively cultivated on the Continent, both for use as a salad plant and for boiling, and is highly esteemed. The

varieties most in request for these purposes are Large Brussels or Witloof, and Red Italian, that known as Large-rooted Chicory being employed for the manufacture of coffee chicory, which is prepared by cutting the roots into thin slices, these being roasted and ground. In addition to cultivation in the open ground, the leaves of Chicory are blanched by such means as growing them in cellars, and the plant is also forced by inserting the roots, tied up in bundles, in beds of hot manure. [W. W.]

When grown for its roots, from 4 to 7 lb. of seed per acre are sown in May, in drills 18 in. apart on good deep land, the plants being afterwards thinned out to 6 in. apart. The roots are harvested in October or November, an average yield being about 8 tons. When dried in a kiln prior to powdering for coffee manufacture, this weight is reduced to about 1¼ ton.

Chicory was introduced into British agriculture about 1870 by Arthur Young, who gave the following as his reasons for its adoption: '(1) the greatness of its produce for soiling on good land, (2) its yielding so amply for feeding sheep on all soils, (3) its being so remarkably applicable in the very poorest and most barren chalks and sands, (4) its forming a most profitable change on all lands upon which clover fails from too frequent repetition'. When grown as a forage crop, from 10 to 12 lb. per acre of seed are broadcasted, and when once established it yields yearly two or three large cuts of green fodder, which is readily eaten by stock. It may also be eaten down by sheep. Being practically proof against drought, it flourishes on light dry soils, which may be considerably improved by following the latter plan. In recent years chicory has been advocated as a constituent of pasture mixtures, chiefly on account of the penetrating power of its root, which will go down to a depth of 3 or 4 ft. even in a hard tilly subsoil. When used for this purpose, 3 or 4 lb. may be included in grass seed mixtures. [J. B.]

Children, Employment of.—Various provisions for regulating the employment of children have from time to time been made by statute, of which the most recent are contained in the Employment of Children Act, 1903, and the Prevention of Cruelty to Children Act, 1904. In addition, restrictions on the employment of children are imposed by the Educational Code in England and Scotland, and by Acts which apply to dangerous performances by children. The provisions of the Employment of Children Act are as follows. For the purposes of the Act, 'child' means a person under the age of 14. Any local authority may make by-laws prescribing the age below which employment of children is illegal, the hours between which it is illegal, and the number of daily and weekly hours beyond which it is illegal; and prohibiting absolutely, or permitting, subject to conditions, the employment of children in any specified occupation. The local authority has also power to make by-laws for the regulation of street trading by persons under 16. The general restrictions on the employment of children are as follows. No child shall be employed between 9 p.m. and 6 a.m.; no child under 11 shall be engaged in street trading; no half-timer under the Factory Acts shall be employed in any other occupation; a child shall not be employed to lift, carry, or move anything so heavy as to be likely to cause injury to the child; a child shall not be employed in any occupation likely to be injurious to his health, life, limb, or education, regard being had to his physical condition. Anyone employing a child in contravention of the Act, or of any by-law under it, is liable to a penalty unless he can prove he used due diligence to comply with the provisions of the Act; and if the offence is committed by an agent or workman of the employer, such agent or workman is liable to the penalty as if he were the employer. A parent who connives at the offence, or any parent or guardian who conduces to its commission by wilful default or habitual neglect to exercise due care, is also liable to a penalty. Any person under the age of 16 contravening the provisions of any by-law as to street trading is liable to a penalty, and in the case of a second offence may, if a child, be sent to an industrial school, or placed under the charge of some fit person until he reaches the age of 16.

The Prevention of Cruelty to Children Act, 1904, provides that anyone causing, procuring, or allowing a boy under 14 or a girl under 16 to beg, whether under pretence of singing or playing, or offering anything for sale, or causes, procures, or permits such child to be in any licensed premises (except those licensed for public entertainment) for the purposes of performing or offering anything for sale between 9 p.m. and 6 a.m., shall be liable to a heavy fine, with imprisonment in addition thereto in the discretion of the Court. The same consequences follow the causing, procuring, or permitting any child under the age of 11 to perform or offer anything for sale in any street, licensed premises, or place of public entertainment, or allowing the child to be trained as an acrobat or for any performance which is dangerous. It is, however, provided that a petty sessional court, or in Scotland the School Board, notwithstanding the provisions of this Act or of the Employment of Children Act, 1903, may grant licenses for any child exceeding 10 years of age to take part in public entertainment, or to be trained as an acrobat, &c., if satisfied of the fitness of the child for that purpose, and that proper provision has been made to secure his health and kind treatment.

In England, provisions were made by the Elementary Education Act, 1876, which have largely been modified by subsequent legislation. It is illegal to take into employment during school hours a child 'under the age of' 12, or, who, being of the age of 12 or upwards, has not obtained a certificate of having reached the standard of education fixed by a by-law for total or partial exemption. The local authority may, however, permit the employment of children for agriculture, provided (1) the children attend school until they are 13, and (2) that children over 11 and under 13 who have passed the standard fixed for partial exemption need not attend school more than 250 times in any one year.

The Education (Scotland) Act, 1901, *inter alia* provides as follows. No one may employ any child who is under the age of 12, or who, being of the age of 12 and not more than 14, has not obtained exemption from the obligation to attend school. No child under the age of 12, or who being of the age of 12 and not more than 14 has not been exempted from obligation to attend school, shall be employed in any casual labour after 9 p.m. between 1st April and 1st October, or after 7 p.m. between 1st October and 1st April.

By the Mines (Prohibition of Child Labour) Act, 1900, no boy under 13 may be employed underground. By the Roads and Bridges (Scotland) Act, 1878, no wagon or cart travelling on any turnpike road in Scotland shall be driven by any person who is not of the full age of 14, under a penalty not exceeding 40*s.*, to be paid by the owner of such wagon or cart. [D. B.]

Chile Nitre. See NITRATE OF SODA.

Chilled Meat.—This name is used to differentiate between meat carried at a temperature of from 28° to 30° F. and frozen meat, which is carried at a temperature of 18° to 20° F.

At first it was considered essential to freeze the meat absolutely, and keep it in this condition, but experience proved that this was not necessary, as a temperature equal to an ordinary winter atmospheric temperature was sufficient to keep the meat in prime condition. In 1877 Mort, the pioneer of the frozen-meat industry, invited a large number of interested persons to his refrigerating works at Lithgow, on the Blue Mountains of New South Wales, and was able to give them a banquet at which refrigerated beef and mutton eighteen months old were the principal dishes. In a speech after the banquet, Mort declared that he owed his success in being able to keep meat so long to 'Faraday's magic wand', for Faraday's discovery of the possibility of liquefying certain gases by pressure, and the capacity of such gases for the absorption of heat on their release from liquefaction, had made the invention of the refrigerating machine possible.

The practical stage was reached when Bell and Coleman of Glasgow in 1879 brought a cargo of meat from Australia which was landed in London in 1880. The *Strathleven*, in which this cargo was carried, was fitted with mechanical refrigerating appliances, and the experiment was eminently successful. The shipping of frozen meat led on by easy stages to the American chilled-meat trade, which began about 1890, and which has now assumed the gigantic proportions of over 260,000 tons per annum exported. There is to-day hardly a steamer trading between the Atlantic ports of North and South America and Great Britain but has its refrigerating equipment for carrying chilled carcasses.

When first imported there was a strong prejudice against frozen and chilled meat, which were believed to be of inferior quality; but this prejudice has now in large measure died out, and as a matter of fact only the finest quality of American meat is sent to the British market, as it does not pay to send the inferior grades. In the United States the live animals are inspected before slaughter, and the carcasses are also subjected to a searching examination by Government inspectors. The slaughtering is done on a large scale, and is carried out by the most approved known methods. After slaughter, meat meant for export has the Government tag attached to it in the chill room, and after two days and nights chilling it is allowed to pass for shipment. All meat for shipment is sewn up in white sheets, which prevents contamination, and to ensure regular temperatures during ocean transit, check self-registering thermometers are put into various parts of the cargo.

Great care must be exercised in the chilling as well as in the thawing of the meat, for if the chilling is too quickly done a crust of chilled meat is formed on the outside, while inside the meat is not affected and quickly deteriorates, and if it is too rapidly brought back to the normal temperature, even properly chilled meat will often become slimy. There is a great difference between properly chilled meat and that which has been carelessly chilled or carelessly thawed, and it often means a considerable loss if either process is badly done. To get the best value out of the meat, the meat purveyor must not only have his cold room in which to store his surplus supplies, but every householder should also have a small cold room or refrigerating cabinet, so as to prevent deterioration and contamination after the meat reaches the kitchen. This cabinet is equally serviceable for home-killed meat, but it is of greater value with chilled meat, as it allows the thawing process to be done gradually, and the juices of the meat are thus preserved.

Objection is sometimes taken to the smell which pervades cold stores where chilled meat is stored, and the fact has often been referred to as proving that deterioration takes place. In comparison with cold stores where frozen meat is kept, where practically no smell exists, the chilled meat stores have always a 'gamey' flavour, but this never makes any difference to the quality or flavour of the meat. Dr. Rideal, as a result of experiments in 1907, came to the conclusion that, so far as nutrient qualities were concerned, and 'with regard to digestibility and for the preparation of soups or beef-tea', chilled, frozen, and freshly killed meat were intrinsically equal in value, and that no incipient decomposition or hydrolysis takes place under cold storage.

There is always a slight loss in weight to the shipper of chilled meat, but this depends mostly on the humidity of the cold stores at the home ports. The loss to the shipper is a gain to the consumer, but the balance either way is a small item. [L. M. D.]

Chillies, the dried fruits of several species or varieties of Capsicum, herbaceous plants that belong to the nat. ord. Solanaceæ, the family which contains other well-known vegetables, such as the potato, tomato, and the egg-apple, as well as the tobacco plant. Chillies are all natives of tropical America, and were first made known to Europe by Peter Martyr the year after the discovery of America. The rapidity with which the different kinds became disseminated throughout the tropical and warm temperate tracts of the globe is one of the

many examples of the marvellous adaptability and powers of endurance possessed by the plants of the New World on their being conveyed to the Old.

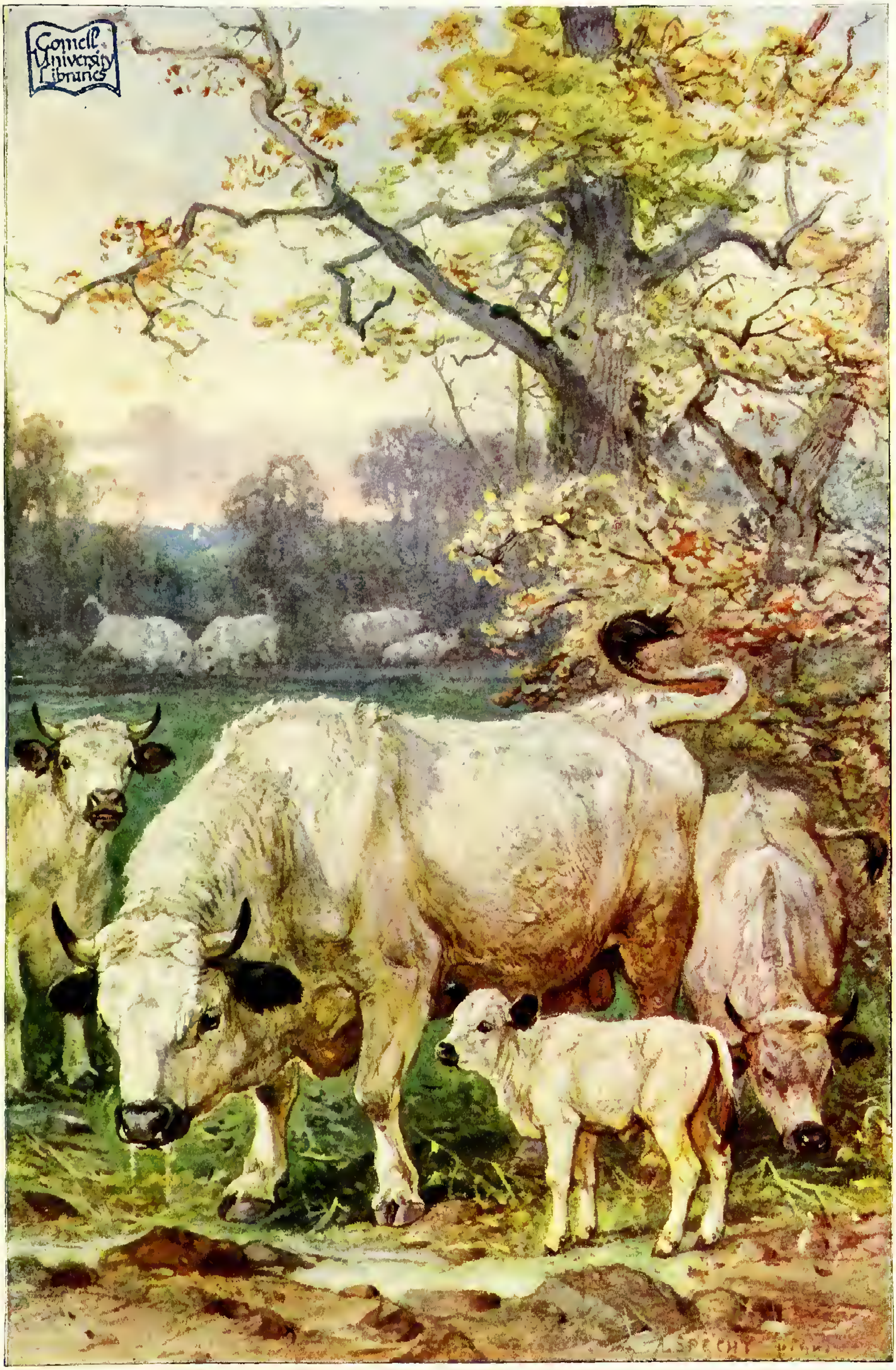
There may be said to be two species, viz. *Capsicum annuum* and *C. frutescens*, with under the former seven and under the latter two varieties. Mention may be made, for example, of var. *acuminatum*, the Long Cayenne, Nepal Chilli, &c.; var. *cerasiforme*, the Cherry-pepper; var. *conoides*, the Coral-gem, Tobasco, &c.; var. *grossum*, the Emperor, Sweet and Yellow Squash, Bonnet-pepper, &c.; var. *longum*, the Black Nubian, Long-red Pepper, Long-yellow Pepper, &c.; and lastly, under the second species or biennial pepper mention may be made of var. *baccatum*, the Bird-pepper, Spar-pepper, &c. These and many other forms are well-known plants of the vegetable garden throughout the tropics, and here and there are grown as field crops. In India, for example, within recent years, field cultivation has greatly extended, especially in the forms of var. *acuminatum* and var. *grossum*. Much attention has been given to the subject of Capsicum cultivation in the United States, and the names given for the special races there produced are endless. Chillies are also largely grown in South America, the West Indies, Egypt, China, &c. Many special forms are also produced in Europe as greenhouse ornamental plants, their brilliantly coloured fruits being their special feature.

The dried ripe fruits with their contained seeds are used in the preparation of Red Pepper or Cayenne, the substance which may be described as constituting their chief feature of commercial importance. In the green or unripe state (especially the forms of *C. frutescens*) they are eaten fresh along with food, or are employed in cookery (whole or sliced). They are also made into special pickles, sauces, &c., and in these forms are carried throughout the world to be consumed as flavouring ingredients with special dishes. [G. W.]

Chillingham Cattle, a breed of wild white cattle found in Chillingham Park, Northumberland. The prevailing colour is white. The cattle are of moderate size and fairly symmetrical, with black or brownish points. The horns are fine and bent upwards, and black tipped. See CATTLE; WILD WHITE CATTLE.

Chills.—Many diseases formerly attributed to chills are now known to be caused by the entrance into the animal body of specific organisms, which gain access by the natural gates or through abrasions in the integument, or the membranes of the respiratory, the digestive, or the genital tracts. Many catarrhal affections (see CATARRH) formerly attributed to chills are now known to be infectious. 'Chilled' udders and intestinal troubles also have been traced to specific organisms. Apart, however, from these known causes, there are many cases of illness among animals due to sudden cooling down or lowering of the temperature, as when exposed to east winds; lying upon frosted pastures; heated by driving, or exposure to sudden changes of temperature during transportation by road, rail, and ship. [H. L.]

Chimneys.—This may seem to some an unimportant subject to occupy valuable space with. Dealt with from the single point of view of the comfort of the farm labourer's cottage, however, it is surely worth a little attention. The lower the house the more difficult is it to make the chimneys thereof effective, and a smoky house is a curse indeed. The chimney of a house is built with the intention that at all times there shall be an upward current of air in the same, else how can one expect smoke to make its way steadily from the fireplace thereby. The difference in pressure of the atmosphere at the chimney head from that at the level of the fire grate is the cause of the draught we refer to. It is evident that the difference in pressure must be slight when the vertical distance between the two points is so small as in the case of a cottage such as we are dealing with, and that very little interference therewith will disturb the balance. Whenever this occurs, some of the smoke from the fire is apt to escape into the apartment. A strong fire in the grate will maintain an upward current on account of the heated gases therefrom being so much lighter than the air round the house that they rush up to find their due state of equilibrium in higher strata of the atmosphere. But the domestic fire is not always bright, therefore it cannot be depended upon to keep the chimney up to the mark at all times. The position of the fireplace in relation to doors, and of the house itself with regard to surrounding objects, are the main factors of interference with the proper action of the chimney. Conditions coming under the former head spoil the draught at its commencing point; those embraced by the other, check it either constantly or intermittently at its point of exit. And of course there are certain rules that require to be observed in the construction of the chimney, in order that it may be on correct lines in this respect. The fireplace must neither be unduly wide nor unduly high—no more space than will allow of a full use of the grate should be given. It should be contracted gradually to the uprising vent, or narrow part of the chimney. And the fireplace must have a complete vent and outlet of its own—no adjoining one must join issue of passage with it. Other than these, no rules can be laid down the observance of which will guarantee regular action on the part of the chimney. Each defective chimney must be dealt with on its own merits, and these, as many of us know, are truly manifold as well as diverse. All the more need, therefore, should he who is responsible see to the chimneys of the dwellings we refer to. These dwellings are seldom very comfortable, and defective chimneys seriously aggravate their discomfort. Much rain finds its way down chimneys that are not often used. This applies to the room chimney of the labourer's cottage, and safeguards should be taken against this where practicable. One who can successfully cope with the seeming vagaries of a cottage chimney may face those of larger houses with some degree of confidence. Oil engines and gas suction plants are quickly doing away with the tall chimneys that are



BRITISH WILD CATTLE IN CHILLINGHAM PARK

requisite at those farms where the oldfashioned egg-end boilers are used for developing steam power. [R. H.]

Chimney - sweeping Machines.—Chimney-sweeping machines are useful on the farm, not merely because they are satisfactorily used to clear the chimney of soot, but they ensure the retaining of this valuable manure, which when obtained in this manner is much richer than that ordinarily put on the market containing no small proportion of furnace dust. A chimney-sweeping machine is convenient also to force out blocks in sewers or drains, often saving much expense that would otherwise be incurred in getting the pipe clean, which might involve taking up a considerable length of the drain. The ordinary chimney-sweeper consists of a number of flexible canes screwed together in convenient lengths, carrying a circular head which adapts itself to the shape of the chimney, while the flexibility of the rods allows the machine to follow the curves and bends of the chimney. [W. J. M.]

Chimonanthus.—The peculiar value of the Winter Sweet (*C. fragrans*, also known as *Calycanthus præcox*), a deciduous hardy shrub native of China and Japan, lies in the fact that its flowers are developed in January. They are cream-coloured, being purplish inside, are charmingly delicate in appearance, and are extremely sweet-scented. It is usual to plant this shrub against a wall having a south or west aspect, and by this means the flowers are displayed to the best advantage, but Chimonanthus has been proved to be quite hardy in the London district. It should be pruned annually to promote the production of young wood, and is usually propagated by layering in the autumn. The flowers last for a considerable time, but unfortunately they are liable to be damaged by severe weather, and on this account are inferior for outdoor effect to those of the Witch Hazels and Cornelian Cherry. The flowers of the variety *grandiflorus* are larger than those of the type, but they are not so fragrant. [W. W.]

Chine, the backbone or ridge of a horse's or other animal's back. This word is also applied to denote that part of the carcass of the pig which includes the spine or backbone.

Chinese Goose.—Goose-breeding in China is very widespread, but our information as to the different varieties met with in the Celestial Empire and Asia generally is very limited. Nor are we aware whether the type known in Europe and America as Chinese, or China, geese fairly represents the races commonly met with in the country of origin. Frequently accidental importations lead to designations which are only partially correct. It has been known for a long period of time that this class of 'knobbed goose' was found in China, as references to it occur in some of the works published a century ago, perhaps before. Sixty years ago several specimens were imported, but did not meet with favour, and it was reserved for American breeders to introduce the breed. In Races of Domestic Poultry, by Mr. Edward Brown, F.L.S. (London: Edward Arnold, p. 189), an account is given of the tests carried out at the Rhode Island experiment station, from which much of our knowledge is acquired so far as the practical value of these birds is concerned. It is stated that 'China geese are not favourites with those who raise goslings for sale to poultrymen, who fatten them and put them on the market as green geese. When a small-boned, moderate-sized goose is required for the fall or Christmas trade, these breeds would prove valuable, as they lay well, and with proper care in selecting breeding stock, large birds should be raised. The Brown Chinese especially seem very vigorous, hardy and active, but pick hard, and require care in dressing to look well. The White China is usually not so difficult to pick, and handsomer in appearance when dressed.' These remarks are confirmed by our own observations in America, and it would appear that the Chinese goose lacks the soft flesh which is characteristic of other races, such as the Embden and Toulouse. Hence they are regarded as more suitable for crossing with soft-fleshed breeds, by which means their hardy nature is advantageously utilized.

In appearance the Chinese goose gives the impression of a short, shallow-bodied bird, which is increased by the somewhat long legs. The chest is carried well up, but is fairly full. The neck is long, and the head long and large. On top of the head is a bony protuberance springing up from the base of the bill, and which, being almost bare, is very prominent. In the White variety this knob is orange in colour, but in Browns it is dark-brown, the bill in both being orange, but darker in the last named than in the former. As just indicated, there are two varieties, namely, Whites, which are very pure in colour, and Browns, in which the body is generally of a greyish-brown, with light grey or white undercolour. The size is medium, 10 to 16 lb. So far as known there is no economic advantage found in either variety over the other. In experience it has been found that this race is rather quarrelsome in disposition, which seriously militates against their popularity. Where smaller geese are desired (see GEESE. BREEDING OF) this breed may be recommended, especially for crossing purposes. [E. B.]

Chinese Pigs.—Many persons claim for Chinese pigs the very considerable improvement made in the feeding qualities of the white pigs in this country during the last six or seven decades. There is little doubt that the aptitude to lay on fat which was observable in pigs towards the middle of the last century was largely due to the importation of those short-legged, wide-backed, and quick-feeding pigs from China and one or two other foreign countries; but it is a moot point if the benefits, if such they were, are still in evidence to any great extent, since the mere laying on of fat is not so much now desired by feeders of pigs as is the production of pork of the highest quality, that which possesses a large proportion of tender, lean meat and only a small proportion of fat. Chinese pigs, like Neapolitans, Small Whites, and Small Blacks, have ceased to be kept pure. [S. S.]

Chionanthus (Fringe Tree), a genus of hardy deciduous shrubs or small trees, princi-

pally attractive by reason of their drooping panicles of fragrant white flowers produced in May or June. They belong to the Olive family, are propagated by seeds or by cuttings of half-ripe wood, are best suited by a sandy loam, and are slow of growth. *C. virginica*, the better of the two species, is a native of North America, and *C. retusus* is a native of China and Japan. [W. W.]

Chionaspis aspidistræ (Brown Fern Scale).—This is a common scale insect on ferns in hothouses. The covering scale of the female is red-brown, and is to some extent mussel-shaped; the male scale is a white felted structure. It also occurs on palms. It is best destroyed by fumigating with hydrocyanic acid gas. [F. V. T.]

Chionaspis salicis (the Ash and Willow Scale), a grey scale which is found encrusting ash, willow, dogwood, &c. When present in large numbers it does considerable damage to sapling ash. The female scale is pyriform in shape, but very irregular. In autumn they become darkened; the female is bright-red, with orange head and black eyes; length of scale, 1·5 to 2·5 mm. The male scale is white, and much smaller than female; length, ·5 to 1 mm. The male is winged, crimson, orange, or red, with hyaline wings; apterous males also occur. The females lay crimson eggs in August and September, and these remain under the scales until the following May, when they hatch into bright-red larvæ, which move over the bark and soon cover themselves with a scale. The males occur in June and July. They also reproduce asexually, but as a rule colonies of male and female scales may be found together.

Treatment.—When ash is badly attacked in plantations, the poles should be barked as soon as cut and the *peelings burnt*. Ornamental trees should be sprayed with lime, soda, and sulphur wash in winter, or paraffin emulsion in June. The lime-soda-sulphur wash is made as follows: Lime, 3 lb.; sulphur, 3 lb.; caustic soda, 1 lb.; soft soap, 1 lb.; water, 10 gal. Make the flowers of sulphur into a paste, then thin and pour over the lime and let boil for quarter of an hour, then stir and add the caustic soda. Let this boil for some time, and then add the dissolved soft soap and full quantity of water. Use only on dormant wood. [F. V. T.]

Chitin, a nitrogenous substance which forms the organic foundation of the cuticle, skeleton, tendons, egg-shells, &c., of insects, spiders, centipedes, crustaceans, and other Arthropods. It is secreted by the epidermic cells and their equivalents. It is characteristic of Arthropods, but occurs also in some other types, *e.g.* in the radula or rasping ribbon of Gastropods and Cephalopods, in the 'cuttle-bone' of Sepia along with lime, in the 'pen' of the squid, in the shell and stalk of the Brachiopod Lingula, and in the bristles of the earthworm. Chitin is very resistant to chemical agents, but may be dissolved in strong mineral acids; it is practically non-digestible. It yields, on decomposition, an amido-derivative of sugar, known as chitosamin, and it is identified in this way when there is enough of it. In cases where the quantity is very small, an identification may be attempted on the basis of physical characters, *e.g.* the specific gravity, which approximates to the value 1·398, and the refractive index, which lies between the limits 1·550 and 1·557. The chemical formula of chitin has been stated as $C_{15}H_{26}N_2O_{10}$ and as $C_{60}H_{10}N_8O_{38} + nH_2O$. [J. A. T.]

Chive, a native perennial (*Allium Schœnoprasum*), the leaves of which are sometimes used in soups and salads in place of onions, their flavour being similar but much milder. The plants are grown in clumps, and the leaves should be frequently cut off close to the ground, as the resulting young growth is more tender. Usually propagated by division of the roots. A new plantation should be made every three or four years. [W. W.]

Chloride of Lime.—Chloride of lime is prepared by passing chlorine gas over slaked lime. It forms a soft, dry powder with a characteristic chlorinous smell. When exposed to the air it gradually becomes moist and sticky and loses its strength. It is also known as bleaching powder or bleach, and as chlorinated lime. It does not consist of the true chemical chloride of lime or calcium chloride, but of a compound of this substance and hypochlorite of lime. It is one of the most important and generally used disinfectants and bleaching agents. Its disinfecting and bleaching power depends on the 'available' chlorine which it contains. This is contained in the calcium hypochlorite and not in the calcium chloride. Calcium chloride, the true chloride of lime, has in itself no disinfecting and bleaching power. The strength of bleaching powder is measured by the amount of available chlorine which it contains. A good fresh sample should contain from 30 to 35 per cent of available chlorine. The available chlorine is gradually given off when the bleaching powder is exposed to air containing carbonic acid gas. It is more rapidly given off if the bleaching powder is mixed with an acid such as sulphuric acid or vinegar. For use as a disinfectant, chloride of lime is generally made into a mixture with 10 to 20 parts of water. It can then be used for washing down premises, and articles which have been contaminated with infected materials, such as the discharges of diseased persons or animals. For washing the hands and person in the case of infectious diseases it is used in a more dilute solution, say 1 part in 100 of water. It should not be placed in metal articles or in metal pipes, as it corrodes and eats away the metal. If used in lime wash it has the disadvantage of leaving the surfaces to which it is applied damp, as the calcium chloride formed absorbs moisture readily from the air. A closely related body, which is also largely used in disinfecting and bleaching solutions, is hypochlorite of soda. [J. H.]

Chlorine is a greenish-yellow gas, and belongs to a group of elements called the halogens. The other elements composing the group are fluorine, bromine, and iodine. Chlorine does not exist in the free state in nature, but it is found widely distributed as salts in combination with metals. The gas is readily liquefied by

pressure to a dark-coloured liquid, which on cooling to a low temperature solidifies. Chlorine readily dissolves in water. One volume of water at 10° C. will absorb 2·58 volumes of chlorine gas. The chlorine water obtained is greenish in colour, and possesses the characteristic smell of the gas. In sunlight, chlorine water slowly evolves oxygen gas, the reaction being as follows:—

$$2\,Cl_2 + 2\,H_2O = 4\,HCl + O_2.$$

Chlorine has a very characteristic and pungent smell, and it attacks and destroys the mucous membrane. It has great affinity or attraction for the element hydrogen, with which it combines, forming hydrochloric acid, as shown in the above equation.

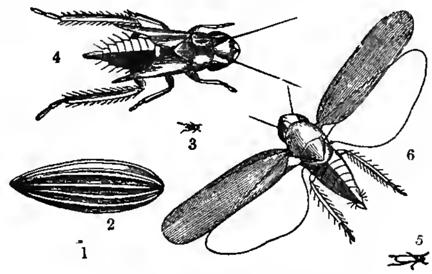
It is very active chemically, and will combine with many elements at the ordinary temperature, producing a flame; thus phosphorus, arsenic, antimony, tin, iron, &c., ignite spontaneously when placed into chlorine gas, and form chlorides. One of the best-known and important properties of chlorine is its power of bleaching and oxidizing substances. Vegetable and animal colouring matters are readily bleached when placed in chlorine in presence of water. The chlorine decomposes the water and liberates nascent oxygen, which is the active bleaching principle. Chlorine attacks many organic substances, forming chlorine derivatives. It also possesses most powerful disinfecting properties. Bleaching powder, which owes its properties to a slow evolution of chlorine, is widely used as a disinfectant. Chloroform is a marsh gas derivative of chlorine.

Chlorine is prepared by the action of hydrochloric acid upon manganese dioxide. For the different methods of preparing chlorine on a commercial scale, the reader is referred to text-books on chemistry. [R. A. B.]

Chlorita flavescens (the Yellow Leaf-hopper).—This is a common insect found on fruit trees, &c. It is 3 mm. long, of a yellowish-green colour, with wings folded tight over the back and narrow in form. It can be recognized by the quaint hopping movements, accompanied by use of the wings. An allied species (*C. viridula*) is usually found with it. They both suck out the juices of the leaves on the under side and cause them to become marked with pale areas; in the plum the leaves often become completely silvery white. In certain seasons they occur in enormous numbers and do much damage. The females lay white spindle-shaped eggs, with long striæ running from pole to pole, beneath the leaves. The young (larvæ) are pale-yellow, and change to forms with wing-buds (nymphs); neither nymphs nor larvæ hop; both these stages also suck the sap of the leaves. They winter in the immature stages in any shelter. Both species are subject to the attack of parasitic Hymenoptera called Proctotrupids, which develop in a dark sac-like process projecting from the body of the Leaf-hopper. These parasites destroy the reproductive faculties of the insects.

Treatment consists of spraying with dilute paraffin emulsion to kill the larvæ and nymphs. The adults can only be destroyed by spraying with soft soap and water, which causes them to fall to the ground, when they are further sprayed with a strong emulsion of paraffin. They may also be collected by jarring them off the trees on to tarred boards. [F. V. T.]

Chlorita solani (Potato Frogfly) abounds upon the leaves of the potato in August and September, either sneaking round to the opposite side of a stalk when disturbed, or making short, skipping flights. The eggs (figs. 1 and 2, natural size and magnified) are white, ribbed, and laid on the under side of the leaves, where the young ones live by sucking the sap with their long sharp beaks. These are green, and as they increase in size they cast their white



Potato Frogfly (*Chlorita solani*)

skins and become pupæ (figs. 3 and 4), when they have two long, very fine antennæ, two large dark eyes, also sheaths for their wings, and six legs. From these they pass into the perfect state, when they are of a lively green colour, and attain four ample wings, which lie over the back when at rest (figs. 5 and 6); the hind legs are long and spiny. They cause the yellow spotting of the potato leaves so frequently seen in dry weather. [J. C.]
[F. V. T.]

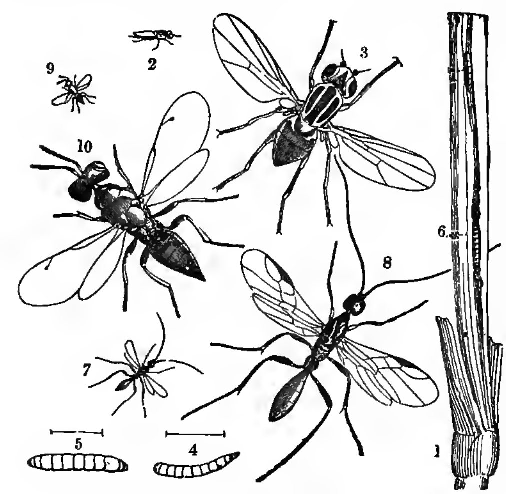
Chlorite, a name for a group of minerals which resemble dark-green micas, but which are softer, and not elastic even in thin flakes. The chlorites are hydrous silicates of aluminium, magnesium, and iron, and some contain as much as 13 per cent of water. The thumbnail scratches them easily. The common aluminous silicates of magnesium and iron, such as augite, hornblende, biotite, &c., alter ultimately into chlorite, just as the non-aluminous mineral olivine alters into serpentine. Hence, as finely diffused plates, tufts, and fibres, chlorites are responsible for most of the green and grey-green colouring in old diorites, dolerites, and other 'greenstones', as well as in sandstones and altered volcanic ashes.

The minerals which yield chlorite on decomposition commonly contain lime, which goes into solution in the soil-waters; and hence the presence of this soft mineral in an igneous rock may indicate that the mass below is still yielding valuable matter as it decays. [G. A. J. C.]

Chlorops is a genus of insects which reduces the value of corn crops to a certain extent by depositing eggs in the young wheat, barley, and rye. These eggs produce maggots, which either eat through the base of the central stalk, de-

stroying the ear, or by working up the straw (see fig. 1), the ear is rendered more or less abortive. There are several species which are engaged in these operations.

C. lineata (the Striped Wheatfly) lays its first brood of eggs in June, when the ears are just appearing; they are placed at the lower part of the ear, at the bottom of the sheath; they hatch in about fifteen days, when the maggots pierce the tender straw and make a narrow channel on the same up the ear. The maggot changes to a brown puparium towards the middle of the furrow, and the flies hatch in September, laying their second batch of eggs upon the rye and other corn recently sown. The fly is yellow; antennæ, and a triangle on the crown, black; thorax with five black stripes; abdomen with dusky bands, and a dot on each



Gout Fly (*Chlorops tæniopus*)

side at the base; apex yellow; legs yellow; anterior feet black, the others yellow; with the two terminal segments black; length, $1\frac{1}{2}$ line.

C. tæniopus (the Gout Fly) is the species which does the greatest mischief in England, causing the disease in barley called the gout, from the swelling of the whole plant. The fly (fig. 2 natural size, 3 magnified) is pale-yellow; antennæ black, and a black triangle on the crown; thorax with three broad black stripes, and a slender black stripe on each side, also a black dot on the side of the breast; abdomen pale-greenish-black, forming four blackish bands and two dots at the base; wings transparent; poisers white; legs ochreous, basal, and two terminal segments of fore feet black; the others, with the two apical segments only, black; length, $1\frac{1}{2}$ line.

These flies also deposit their eggs between the leaves of autumn corn, grasses, &c., in the autumn, when the maggots live in the base of the stem. They may destroy the shoot, or render the ears unproductive—the corn sometimes altogether failing; in most instances, one side only of the ear, with the greater portion of the grain, becomes shrivelled. The maggots (fig. 4) are whitish, shining, tapering to the head, blunt and tubercled behind, the elliptical puparia (fig. 5) are of a rusty colour, and fixed in the groove of the stalk (fig. 6), or inside of the closed leaves; from which the flies crawl forth with their crumpled wings in August, and are found in stacks through the winter. At times the ear never bursts out of the sheathing leaves, but other ears may do so, and thus part of the grain matures. Attacked plants often only reach 6 in. high.

There is a parasite, named *Cœlinius niger* (fig. 7, magnified at fig. 8), which punctures the maggots; and these again fall victims to the beautiful little *Pteromalus micans* (fig. 9, magnified at fig. 10). Early sowing is one of the best preventives, and the application of a stimulating dressing to carry the crop along. Rough grasses in the headland and around ditches and hedges should be cut down and burned during winter. [J. C.] [F. V. T.]

Choking.—An obstruction anywhere between the back of the mouth and the stomach is understood by the term 'choking' when applied to animals, and does not include the accidental passage of substances into the air passages, as when persons accidentally get something 'the wrong way'. Such accidents do occur in animals in the administration of medicines, and broncho-pneumonia and even fatal consequences ensue. Horses as a rule comminute their food and insalivate it more perfectly than ruminants, and are therefore less frequent subjects of choking. They are also more generally fed upon rations prepared, and but rarely offered whole roots or apples. The custom of giving whole hen's eggs, in conditioning horses, has led to choking, through the breaking of the shell, and is to be deprecated. Greedy horses sometimes get choked by carrots, swedes, apples, and other things, including hay; but it has usually been found that those which have been the subject of chokings by 'long stuff' have been the victims of sacculated gullets, in which the food accumulates through failure of the dilated portion to contract upon its contents and continue the process of deglutition, which commences in the pharynx and is an involuntary act as soon as the dorsum or arch of the tongue has been passed by the prepared morsel. The gullet of the horse is relatively smaller than that of the ox, and the symptoms of choking much more severe. Great distress is exhibited: the neck is arched, its muscles thrown into spasm; saliva dribbles from the mouth; the countenance is expressive of fear, the eyes and nostrils distended, and the animal paws the ground and behaves more or less like one suffering from colic. The flanks may be distended by retained gases in the stomach and bowels, and flatus from behind accompany the condition. The frequent ineffectual attempts to swallow, and the depression of the chin towards the chest by spasmodic efforts, should enable anyone to diagnose choking. The same symptoms indicate the trouble in cattle and sheep, but are commonly much less acute. The beast or the sheep is not so

frightened, and its lymphatic temperament disposes it to more or less resignation, which often results in spontaneous relief. *Treatment* should be directed to softening the morsel, and in nearly all cases to pressing it downwards; but there are a few cases of high choking being relieved by withdrawal from the mouth by instruments. Repeated small quantities of linseed oil should be passed into the throat, with a view to soften and lubricate the parts. If the obstacle can be felt from the outside, a very little compression may overcome the hindrance. The probang should only be resorted to when other means have failed, and farm hands should be warned against the employment of cart whips, which may break off and cause a fatal

Probang

termination. Immediate death from suffocation need not be feared while professional assistance is being sought. Choking is of less frequent occurrence where root cutters are employed. [H. L.]

Cholera of Pigs. See SWINE FEVER.

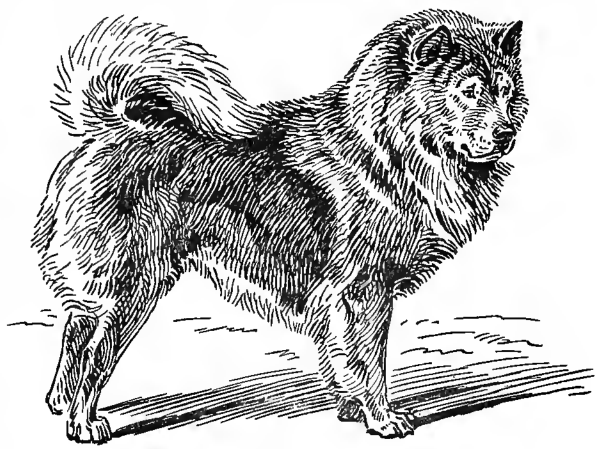
Chopin, a Scotch liquid measure containing 2 imperial pints or 1 quart.

Chorea, a nervous affection in which muscular twitching is the characteristic symptom. While more frequently affecting the muscles of the neck and fore extremity, it not rarely causes similar rhythmic contractions of one or both hind limbs. Localized muscular spasms which could be called chorea are rare in horses and cattle, but in dogs of very frequent occurrence as a sequel to distemper. Chorea may supervene during the illness, or may follow upon an attack so slight that the owner has not recognized distemper at all. It varies much in degree, some dogs being only observed to 'bob' their front parts at particular moments, or to twitch during sleep as if dreaming; while in others sleep is so disturbed that the patient wastes, and finally becomes paralysed. Although it has been associated with red softening of the spinal cord, no lesions whatever could be discovered in many cases examined after death. A course of arsenic, iron, and other remedies has in some cases appeared beneficial, but treatment as a rule offers but little prospect of cure. [H. L.]

Chorioptes. See SYMBIOTES.

Chow Chow. — The appearance of the Chow Chow, popularly described as the edible dog of China, was greeted with some degree of hilarity about twenty years ago, but since that time the merits of the breed have become better appreciated, and though his increased popularity is not based upon his culinary value, the distinguished celestial is now a conspicuous feature of all the leading dog shows.

In appearance the Chow Chow somewhat resembles a large and rather coarse-looking Pomeranian; not that the breed is by any means destitute of grace, but on account of many of the Pomeranian points being broadened. For instance, the skull of the Chow Chow is not only larger, as is but natural, he being the heavier dog, but it is likewise bigger by comparison with that of the other. His muzzle, too, is more truncated, his ears less pointed and coarser, his eyes deeper set in his head and smaller, whilst his skull is plentifully endowed with wrinkles. The Chow Chow, too, is built upon far heavier lines than the Pomeranian; but the two varieties possess the tightly curled tail, the luxurious coat—that of the Chinese variety being rather the harsher—and a similar vivacity and alertness of temperament which not infrequently causes unobservant persons to regard the two varieties as being identical with



Chow Chow

each other. There is, however, one point of distinction between the Chow Chow and the Pomeranian which renders it impossible for even the merest tyro to connect them. This is the colour of the tongue and inside of the lips, which in the case of the former variety are of a deep purple, in fact almost black colour, whereas those of the Pomeranian are of the orthodox red. The dark interior of the mouth is a characteristic of most, if not all, Chinese breeds, and the property being distinctly portrayed in the case of the Chow Chow, leaves no grounds for believing that there is anything of a common ancestry between him and the Pomeranian.

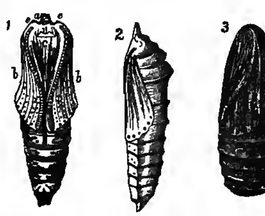
As regards his utility there is a good deal to be said in favour of the Chow Chow, independently of course of his merits as a comestible, which are not regarded favourably in this

country. He is a fine companion, a good and reliable house dog, very intelligent, and of a fairly hardy constitution after he has survived the ills of early puppyhood, which often affect him greatly. Amongst his chief virtues may be included his absolute devotion to his master, which is none the less conspicuous because of his natural disposition to keep strangers at a distance. Though by nature he may appear to be suspicious and unsociable, the Chow Chow possesses many sterling qualities, conspicuous amongst which is attachment to his home. He is not, however, a dog that cares for petting, and as a rule he is not in the habit of bestowing his affections upon more than one or two members of the household. Undemonstrative though he may be by nature, his disposition is eminently sincere, and though he may not always be gambolling at the side of his master when out for a ramble, he is pretty certain to be at hand when wanted, and ready to take his own part if called upon to do so. Possibly his intelligence is not of the very highest order, that is to say so far as his powers of acquiring accomplishments and learning to perform tricks are concerned, but the Chow Chow is essentially a dog that is able to take care of himself, and as such succeeds in making many friends.

The chief colours met with in the Chow Chow are red and black, his skull being rather large, his muzzle powerful, and his body short and compact, his legs appearing to be shorter than they really are in consequence of the profuseness of his coat. [V. S.]

Christmas Rose. See HELLEBORUS.

Chrysalis, the term employed to denote the quiescent stage in the life-history of the



1, 2, Chrysalis of the White Butterfly Moth. *a*, Palpi or feelers; *b*, *b*, wing cases; *c*, sucker; *e*, *e*, eyes; *x*, *x*, antennæ. 3, Chrysalis of the Oak Egger Moth.

Lepidoptera. It is the period when the caterpillar is being changed into the butterfly, or the larval form into the perfect insect (Imago). In this transitional stage no food is taken up as a general rule, and movement is entirely absent. The outer covering of the chrysalis consists of a thickened chitinous covering, on the surface of which the parts of the future insect—limbs, wings, antennæ—are clearly marked. In the case of many butterflies and moths, however, the chrysalis may be enclosed in a cocoon. Both the external appearance and the duration of the chrysalid stage vary with the particular insect and with the period of the year. [R. H. L.]

Chrysanthemum, a genus of composite plants marked by (1) watery juice; (2) two kinds of flowers in the head—the outer ray flowers, strap-shaped, and the central disk flowers, tubular; (3) the flat axis (receptacle) on which the flowers are seated; and (4) the round or angular fruits, vulgarly called seeds. The Daisy (Bellis) has also watery juice, and two kinds of flowers in the head, but the axis is conical and not flat, and the fruits are quite compressed and not round. Our two native species of Chrysanthemum are mere weeds, namely: (1) *Chrysanthemum Leucanthemum* (see OX-EYE DAISY), with a white ray; (2) *Chrysanthemum segetum*, with a yellow ray (see CORN MARIGOLD). For cultivated species see next art. [A. N. M'A.]

Chrysanthemum, a genus comprising upwards of a hundred species of herbaceous or slightly shrubby plants, distributed over the four northern continents. *C. segetum*, Corn Marigold, and *C. Leucanthemum*, Ox-eye Daisy, are British species, the latter, in common with varieties of *C. carinatum*, *C. frutescens*, Paris Daisy, and some others, being extensively cultivated in gardens; but they have become quite overshadowed in point of importance by forms of *C. sinense*, which being first introduced in 1764, did not become remarkably popular until nearly a hundred years later. During the latter part of the 19th century, however, the cult of the Chrysanthemum assumed mammoth proportions, and to-day no greenhouse plant can be said to excel it in a popularity which is almost world-wide. The production of mammoth blooms of the Japanese and Incurved varieties has up to the present been the most usual aim, and if there are signs of a slight slackening of competition in this respect, the increasing favour of the many-flowered single kinds, and the advent of a large number of fine early sorts suitable for flowering in the open ground, certainly assure that in the future the Chrysanthemum will be an even more universally esteemed and generally cultivated plant. The details most important in the pot cultivation of the Chrysanthemum are that from the taking of the cuttings to the flowering stage the plants must never receive a check, that they should be grown in a rich compost, and that they should receive liberal additional feeding from September onwards. When large specimen flowers are wanted, the stopping of the shoots and disbudding are matters requiring a knowledge of the peculiarities of individual varieties to obtain the most perfect results. [W. W.]

Chrysanthemum, Parasitic Fungi.

RUST.—During the past twelve years this has become destructive to cultivated chrysanthemums in this country. As a rule, it is first seen on cuttings, or on the lower leaves of older plants in autumn, and is recognized by the chocolate-brown pustules, from which uredospores, and rarely teleutospores, of a rust fungus (*Puccinia*) are shed over the foliage.

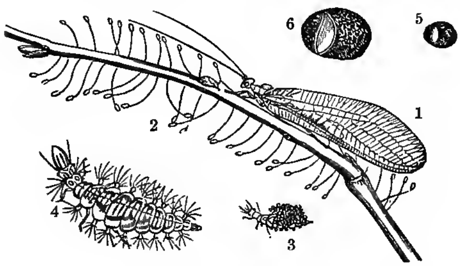
Treatment.—Instead of using fungicides when the disease is destroying the plants, keep the rust in check by preventive measures; the following are suggested by an experienced grower. After flowering is over, collect and burn all withered and fallen leaves; remove any rusted leaves observed in spring and summer, and spray the foliage and soil once a month during sum-

mer and winter with potassium sulphide ($\frac{1}{2}$ oz. to each gallon water). Isolate rusted plants, and so prevent infection. As newly purchased plants may introduce rust into a healthy collection, they should be kept under supervision for some time. Cuttings should only be taken from healthy plants. Some varieties are more resistant to rust, and where possible these should be propagated in preference to less resistant ones.

Powdery Mildew (*Oidium*), one of the Erysipheæ (see Fungi), is also common. The white cobweb-like mould is generally confined to the surface. It may be taken as a hint that ventilation is needed, and if it becomes too abundant it may be checked by fumigation with sulphur (see Fungicides).

Leaf-spot.—Several fungi have been blamed as the cause of brown spots which enlarge into discoloured patches, till finally the leaves wither completely. If cuttings are killed in this way it is simplest to burn them; in the case of older plants, the plucking of dying leaves and the treatment recommended for rust will check the disease. [w. g. s.]

Chrysopa perla (the Golden-eye Fly) is a very remarkable and useful creature which



Golden-eye Fly (*Chrysopa perla*)

destroys the aphides. The fly is pale-green, with long antennæ; the eyes golden-green; and the four wings are like gauze, iridescent, and ornamented with green veins. It sits with its wings closed (fig. 1), and the female attaches her white eggs to twigs and leaves by very fine stalks (fig. 2). These produce ferocious-looking larvæ, called aphis lions, which clothe themselves with lichen and dead aphis skins for better concealment (fig. 3; fig. 4 is the same magnified, but denuded of its artificial covering). They have long jaws to catch the aphides on which they feed, and spin a white silken cocoon, covered with lichen, to change into pupæ (5, magnified at 6); when the insect is ready to hatch, it is liberated by a lid, which opens and allows the animal to emerge in a silken skin, which it soon shakes off, after which the wings expand. [j. c.] [f. v. t.]

Chrysops cæcutiens (Cleg or Clegg).—This brilliant-eyed biting fly is one of the Tabanidæ or Gad Flies. It is also known as the Blinding Breeze Fly. The bite of this insect is very painful; man, horses, and cattle are attacked by it, especially in very warm bright weather. The female is dark-brown, the thorax with two cinereous stripes, and clothed with tawny hairs; the abdomen with a broad tawny orange band at the base and a row of tawny triangular spots along the back; the wings are brown with two large colourless areas; the eyes are golden-green with purple hind border and spots; the male is black, the abdomen tawny on each side towards the base. The length varies a little under to a little over $\frac{1}{3}$ in.; the wing expanse from over $\frac{1}{2}$ to nearly $\frac{2}{3}$ in. It is widely spread over Britain. Three allied species also occur (*C. quadrata*, *C. relicta*, and *C. sepulcralis*).

The eggs of Chrysops are deposited in masses in one flat tier on rushes, etc., over water. The larvæ are pale footless grubs, and live in damp mud, sand, and vegetable debris. They are carnivorous, feeding on earthworms, snails, &c. They occur singly, and their flight is silent. [f. v. t.]

Churning. — To find the art of butter-making in its rudimentary state, we should have to go so far back that no one can now hope to learn anything about its origin. It is more than probable that the way to get butter from milk was accidentally discovered before milk was suspected to contain so solid and tangible a thing as butter at all, and this too in the early infancy of humanity. By some of the nomadic people of the East, milk is still churned in goatskins suspended from tree boughs or dragged at a horse's heels as he gently canters along. Elsewhere other primitive ways of churning still survive, but the goatskin seems to have been, and to be still in some Eastern lands, the almost universal churn where butter has been made right along from prehistoric times. Throughout mediæval periods, even in Western Europe, where in modern times buttermaking has made well-defined advances on the road to perfection, the art of dairying was non-progressive for centuries until the middle of the last one, since which time more has been done to improve the art than in all previous time. This great awakening, however, is only collateral with the amazing progress that has been accomplished in all departments of human activity.

Room for the cultivation of art and skill may be found by those wishing to find it, even in so apparently elementary a process as that of churning; and especially applicable is such a statement to the course which cream has need to go through in its preparation for churning. The salient object of churning is to liberate from milk the butter-fat which is held in suspension therein, and this is realized by the combined manual and mechanical act and process of churning. Looking at a flattened drop of milk under the lens of a microscope well lit up and powerful enough for the purpose, an opaque fluid is revealed as a galaxy in which tiny luminous orbs are numerous. These orbs are cream globules, which appear to be enclosed in membranes of infinite tenuity; but whether or not they are actually so enveloped is a point upon which differences of opinion exist. Be that as it may, the violent agitation and concussion to which cream is subjected in the process of churning liberates butter from cream, and enables it to float on the surface of buttermilk when at rest,

exactly as cream has previously floated on skim milk in cream raising. By merely standing at rest, milk allows its cream to rise to the surface, as an act of separation; but agitation—thrashing—concussion—is necessary to induce cream to give up its butter in the act of churning.

Various preconceived theories as to the speed at which churning should proceed have been somewhat disturbed by the advent of such high-speed churns as Bradford's 'Fishback', which produces high-class butter by means of mechanical velocity ten times as great as that allowed in the case of barrel churns. There is, however, some licence permitted in the speed of barrel churns, in regard to the season of the year, temperature of the air, ripeness of the cream, and so on; but the fact remains that while barrel churns are at their best in work when going at 45 to 50 revolutions, fishback churns do good service when the shafts with projecting beaters are driven at 400 to 500 revolutions. This is owing to the different character of the agitation employed in the two churns respectively. A steady, fairly uniform speed in churning is tolerably certain to afford the best results, provided the churn, as well as the cream, has been properly prepared for its work, in accordance with the state of the weather and the condition of the cream at churning time. Training and practice are required to make anyone expert in all the points that have their weight and influence in the dairy.

[J. P. S.]

Churns.—The churns that have been designed—most of them enjoying only a short career—must be endless so far as variety goes. Probably the earliest was a simple bowl, or a gourd, or a cocoanut shell, in which cream was stirred about with a stick. Nomadic tribes in Eastern lands are said still to use the primitive churns of prehistoric ages. Goatskins containing cream and roughly swung about are said to be not yet obsolete in the East. The gradations from goatskins to butter extractors would provide a quite bewildering variety of these useful appliances, which, to a great extent, had a brief day and then vanished from the scene. The barrel churn is an old one, perhaps as old as the plunge-dash churn, and it still retains a greater hold than any other on the fancy of dairymaids. The plunge-dash churn, indeed, is moribund, and must in time be classed amongst the vanished equipments of dairies. Under various adaptations, of which the end-over-end form is the principal, the barrel churn has not only survived all recent changes in dairy equipment, but is more firmly established now than ever before. The barrel-shaped body has long been acknowledged as the *ne plus ultra* in the larger churns for hand power, nor is it discarded in churns for power beyond that of an arm or a pair of arms. The element of variety is introduced in parallel, straight-side churns, with the same diameter from one end to the other, or with a taper towards the top, but still straight-sided. We may look in vain on this shape of

Fig. 1.—Bradford's 'Diaphragm' Churn

churn body for any merit of consequence save that of variety. For ordinary barrel churns of typically curved sides, the axis of rotation lies

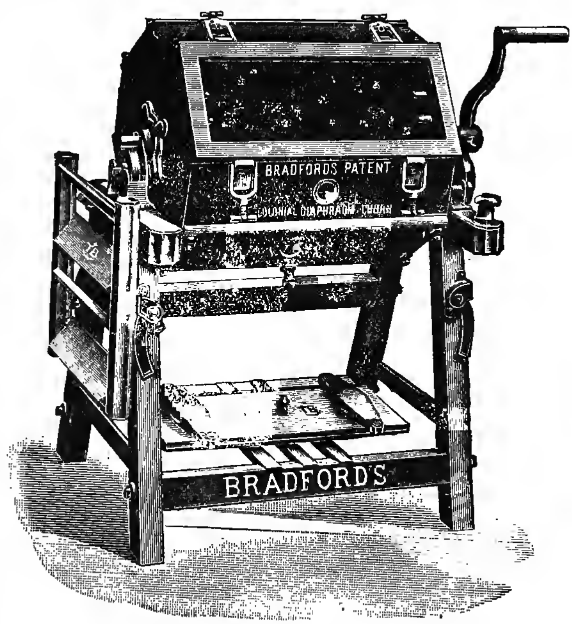


Fig. 2.—Bradford's 'Colonial Diaphragm' Churn

from end to end, and in these churns fixed 'beaters' are attached to the inner rotundity, their function being to enforce maximum agitation in the cream as the churn revolves. This

is the original type of barrel churn, so far as we know, greatly improved in bearings, and also in construction, within recent times.

The same churn in form is also constructed

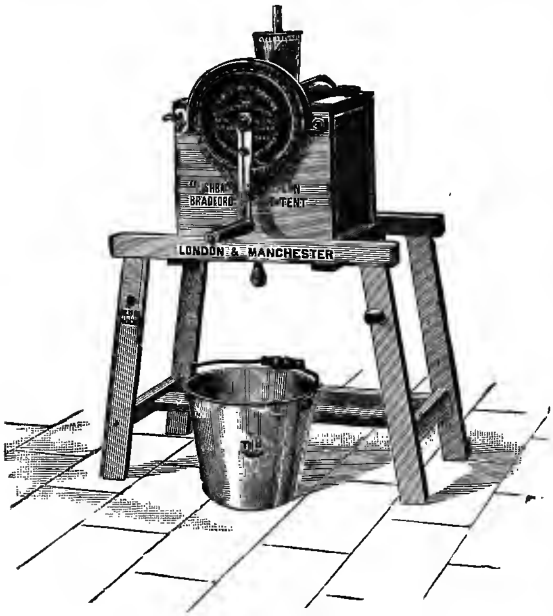


Fig. 3.—Bradford's 'Fishback' Churn

as an 'end-over-end' churn, its line of axis being from side to side through the greatest diameter, to which the axle bosses are attached. The lid of this churn forms one of its two ends, and it is not unpopular in some places, though it does not contain any beaters, the required agitation being obtained by the repeated tumbling of cream from one end to the other, and almost immediately back again. Ordinarily, this type of churn answers fairly well with ripened cream, but it is almost useless with cream inclined to be 'sleepy', which is not uncommonly the case. There is also an end-over-end churn which contains most effective beaters; these, by the way, are readily removable for cleaning. This is known throughout the dairy world as the 'Diaphragm' churn, invented by the late Mr. Bradford of Manchester, whose son now holds the patent and makes the churn. This diaphragm arrangement of beaters is, to say the least, equal in its effect on cream to any other form of beaters so far designed. It possesses the great advantage of being instantly detachable and quickly taken out of the churn. The style of the diaphragm is seen in fig. 1, where lid and diaphragm too are placed where they can dry after being washed. Another form of diaphragm churn is seen in fig. 2, and named the 'Colonial Diaphragm', to distinguish it commercially from its mate. This, as will be perceived, has an octagon barrel, and a wide lid opening to admit the diaphragm, but its line of axis is from end to end of the barrel. The facility afforded for quickly and thoroughly cleaning the insides of these different diaphragm churns is self-evident. Detachment of the diaphragm leaves the interior of the churn without obstruction to cleaning and inspection, and this is a manifest advantage. The first one possesses all advantages claimed for the beaterless end-over-end churn, and in addition there is the unique diaphragm arrangement, which may be used at will or left unused as the choice may be. The choice will seldom lie in keeping the diaphragm idle. These churns with diaphragm arrangement are also made in large sizes for use in big establishments.

High-speed churns for quick churning have been introduced in several varieties, some of which have fallen behind in the race for supremacy, and apparently have left the course to the rest. For churning small quantities of cream daily to supply a family with butter from home-produced milk, these quick-acting churns are most of all convenient. Bradford's 'Fishback' churn was one of the very earliest of this type of churn, as it is now perhaps the best known of them all.

A new variety, called Garbutt's 'Two-minute' churn, is more recent in evolution, but has already won a good name for itself. This churn, like Bradford's 'Colonial Diaphragm', is octagonal in shape, and its line of axis is from end to end and horizontal. The beaters in this churn are of peculiar form, which, apart from explanation, must be regarded as adventitious, and at the same time effectual, inasmuch as the churning is completed in remarkably short time. This, however, is owing

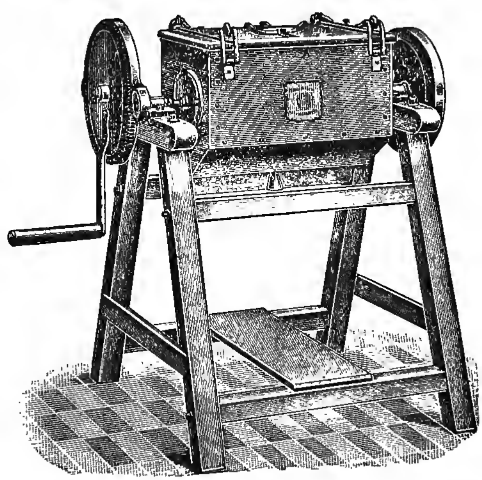


Fig. 4.—Garbutt's 'Two-minute' Churn

in no small measure to the great speed of 400 revolutions per minute which the beaters attain —a velocity which can hardly fail, at all events, and especially in hot weather, to be detrimental to the grain of the butter.

The 'Morning' churn is another product of the inventive genius of the late Mr. Thomas Bradford. It was brought out to meet the needs

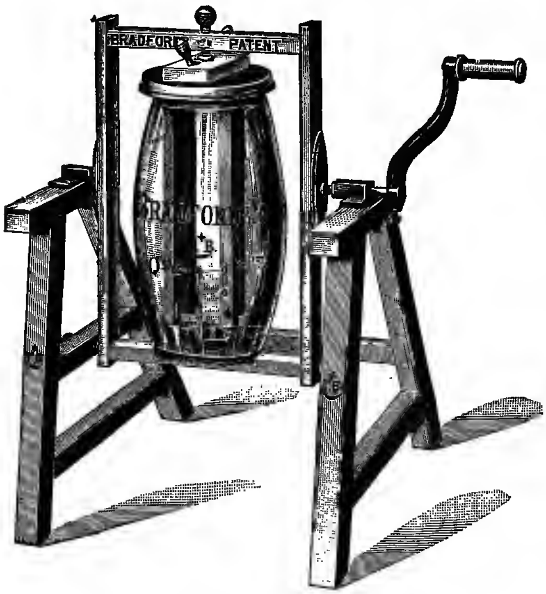


Fig. 5.—Bradford's 'Morning' Churn

of persons who keep a cow or two and want to enjoy their own butter. It is a toy in a way, but a thoroughly practical toy, and decidedly

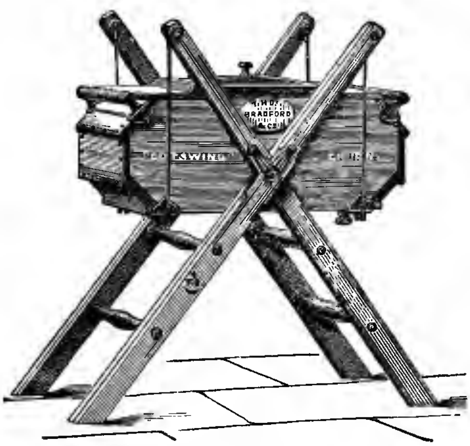


Fig. 6.—Bradford's 'Cotswing' Churn

useful and popular. The 'Cotswing' churn is designed for use in small dairies, and has won its way into popular favour. [J. P. S.]

Cicely. See Sweet Cicely.

Cicer (Gram). See Chick Pea.

Cichorium, the genus of composite plants to which Chicory and Endive belong. See Chicory and Endive.

Cicuta, the botanical name of the plant commonly known as Cow-bane. See Cow-bane.

Cimex lectularius (the Bed Bug).—The Bed Bug belongs to the piercing-mouthed order of insects called Hemiptera. It lives in cracks and fissures of human habitations, under carpets, furniture, &c., and attacks persons and even animals at night. It is brownish-red, quite wingless, and varies from $\frac{1}{6}$ to $\frac{1}{5}$ of an inch long. The female lays fifty whitish eggs three or four times a year, laid in crevices in the floors, &c., of buildings. The bug takes one meal of blood between each two moults and before egg laying. The egg stage lasts seven to ten days. From the hatching of the young to maturity the time varies from seven to eleven weeks. The young are at first pale-yellowish-white, and gradually grow into the adult; five moults take place. They probably carry diseases. [F. V. T.]

Cinchona, a genus of trees belonging to the order Rubiaceæ, natives of the Andean regions of Bolivia, Peru, and Ecuador, and met with between the altitudes of 3000 and 9000 ft.—now extensively cultivated in India, Ceylon, Java, Jamaica, South America, &c. They are of interest because of yielding the 'Peruvian Bark' or 'Jesuit's Bark' from which the alkaloid 'Quinine' is prepared. The following are the more important species: (1) Pale Cinchona, or Crown Bark (*Cinchona officinalis*), indigenous to Peru and Ecuador; (2) Yellow or Calisaya Bark (*C. Calisaya*), a native of the forests of Bolivia and South Peru—the most extensively cultivated of all the species, more especially the variety *Ledgeriana*; and (3) Red Cinchona Bark (*C. succirubra*)—formerly an abundant tree in Ecuador, but now almost confined to the western slopes of Chimborazo.

None of the medicinal species will stand frost, though they all require a cool climate in which there is no great range in temperature between summer and winter or day and night (from 49° to 69° F.). The Red Bark, the least popular of the cultivated species, is the hardiest, grows to a fairly large size, and can endure a considerable range of temperature (from 40° to 80° F.). They may be raised from seed or grown from cuttings or layers. Seedlings are the better for being pricked out once or twice and replanted, but when 9 to 10 in. high should be placed in their final positions 4 to 6 ft. apart, according to species and locality. The red bark, since it becomes a considerable tree, would need greater space than the crown bark, which is only a medium-sized tree, or than the yellow bark, which is only a small tree or bush. Wide planting would thus obviously be an error, more especially for the last two forms. The first crop is obtained by thinning out the plantation, when perhaps 25 per cent may be removed, and the thinning continued during the fifth and sixth years of growth, when perhaps not more than half the original plants would thus ultimately remain. The bark is richest in alkaloid when from four to seven years old, after which date it gradually deteriorates, so that the practice

now followed is to completely uproot the plantation every ten to twelve years. The roots are carefully removed and washed, since if anything the bark from these is more valuable than from the stems, and very much more so than from the branches. The bark is stripped, care being taken to carry away none of the wood below. But in addition to the modern system of felling, uprooting, and renewing, in some plantations the trees have their branches lopped off or they are periodically coppiced, the bark being taken from the portions removed, and the plants then helped to produce a further and continuous supply. Formerly a system of barking and mossing living stems prevailed; that is to say, layers of the bark were stripped off the trees, and the wounds thus inflicted were covered over with moss till the bark was renewed. By whichever process obtained, the bark is dried, then packed and despatched to the factory where the quinine is manufactured. There are thus known in trade 'Root-bark', 'Quill-bark' (from thin branches), 'Shavings', and lastly 'Flat Bark' (that from the stem and larger branches). [G. W.]

Cineraria, a genus of Compositæ, several species of which are grown in gardens, the most popular being *C. cruenta* from the Canary Islands. This is the parent of the greenhouse cinerarias, herbaceous annuals with large, cordate, lobed leaves and erect, crowded racemes of handsome flowers remarkable for their bright colours. There are two well-marked races, the large-flowered and the star-flowered (*stellata*). These come fairly true from seeds, and are not difficult to cross-fertilize. The seeds are sown in May or June in a greenhouse or frame, and when the seedlings are large enough to handle they are pricked into pans of light soil and kept in a cool frame. From these they are planted singly in 4-in. pots, and again later into 6-in. or 8-in. pots. They should be kept in a cool frame and shaded from bright sunshine. The flowers are developed from January onwards. The largest have flowers which measure fully 3 in. across, but the plants are squat and less decorative than those of the stellate section, which are a yard or so high and loose in habit. [W. W.]

Cinnabar Moth.. See EUCHELIA.

Cinquefoil. See POTENTILLA.

Circulation of the Blood.—The blood of vertebrate animals is contained within a closed system of vessels consisting of the heart, arteries, capillaries, and veins. Associated with these are the lymphatic vessels, which return to the blood the plasma or lymph which, by way of the capillaries, leaves the vascular system for the purpose of conveying nourishment to the tissues. With these, however, we are not concerned in our consideration of the circulation of the blood. In order to understand the mechanism and course of the circulation, we require to be familiar with the leading features of the structures by means of which it is carried out, and these we shall now briefly describe.

The heart of a higher animal, such as one of the domestic animals, is a muscular organ containing four cavities or chambers, known as the right and left auricles and ventricles. The auricle and ventricle of each side communicate with each other and with vessels (arteries and veins) entering and leaving the heart, but in the adult there is no communication between the right and left sides of the heart except indirectly through the capillaries of the body. The veins and arteries generally resemble each other in structure, but there are one or two points of difference worth noting. The former are less muscular, of greater diameter, and possess valves for preventing the backward flow of the blood. Veins convey blood to the heart, while the arteries carry blood from the heart to the body. Except in the case of the pulmonary circulation, where the reverse takes place, veins carry impure blood (venous blood), and arteries carry pure (arterial) blood. With the exception of the spleen and one or two other organs, in all parts of the body the connection of the minute arteries with the corresponding veins is effected by means of a network of very minute thin-walled vessels known as capillaries.

The course of the circulation is as follows. The impure blood enters the heart from the veins at the right auricle. From here it passes to the right ventricle, whence it is driven by the pulmonary artery to the lungs, in the capillaries of which it is aerated and becomes arterial blood. Through the pulmonary veins the now purified, *i.e.* oxygenated, blood passes to the left auricle. From here it enters the left ventricle, whence it is conveyed by the aorta to the arteries, distributed throughout the body by these, and passing through the capillaries reaches the veins. By the veins it passes to the right auricle of the heart, thus completing the cycle. There are many proofs that the blood circulates, derivable from the structure of the heart and vessels, and by experiment. The simplest and most satisfactory is that of directly observing it, as may be done in the small vessels of a frog's foot, or in those of a developing chick, fish, or other animal. The chief cause of circulation is difference of pressure in different parts of the system, produced by the contraction of the heart, and also by the elasticity of the arterial walls. This latter factor comes into play between the heartbeats. The arrangement and character of the valves of the heart and veins determine the direction of flow. The purpose of the circulation is that of oxygenating the blood, the carrying of nutriment to the tissues, and the removal of waste. [J. R.]

Cirsium (Plume Thistles).—This is a generic name often applied to those thistles whose fruit is crowned with hairs which are branched and featherlike. The creeping thistle is called sometimes *Carduus arvensis* and sometimes *Cirsium arvense.* In the same way, *Carduus palustris* may be called *Cirsium palustre,* and *Carduus lanceolatus, Cirsium lanceolatum.* See CARDUUS.
[A. N. M'A.]

Cistern, a tank or reservoir for containing liquids. Most frequently the cistern is a receptacle for holding pure water; in this case it may be built of brick or of wood lined internally by sheet metal.

Cistus, a genus comprising thirty species of erect shrubs or sub-shrubs, natives of the Mediterranean region. Their flowers are large

and showy, appearing in June or July, but they do not last well. Cistuses are only an entire success in this country when planted in dry, warm situations, and even so they are liable to be killed outright by prolonged severe frost. They are best suited by a sandy soil, and by full exposure to the sun. *C. ladaniferus*, 4 ft., Gum Cistus; *C. laurifolius*, 6 to 8 ft., white flowers, the hardiest kind; and *C. purpureus*, 3 to 4 ft., reddish-purple flowers, are representative species. There are numerous varietal forms, and some hybrid kinds. Easily propagated by seeds or cuttings. [W. W.]

Citric Acid, an organic acid whose chemical composition is represented by the formula $C_6H_8O_7$. It occurs in the free state in fruits such as lemons, oranges, cranberries, &c. Citric acid may be prepared by allowing lemon juice to partially ferment, and then boiling with chalk and lime. From the calcium citrate so formed, citric acid may be extracted by the addition of sulphuric acid. Citric acid is present in the cell sap of all plants, and the solvent action of plant roots has been attributed to the presence of this acid in the root hairs. A 1-per-cent. solution of this acid is used in determining the available phosphates in the soil, and the phosphoric acid in basic slag. See also SOIL IN RELATION TO PLANTS. [R. H. L.]

Citrus.—The Orange, Lime, Lemon, Citron, and the Pomelo are all derived from this genus, and are members of the Rutaceæ. They are small trees or bushes, cultivated in all tropical and subtropical countries. The orange seems likely to have originated in China, the lime in India, the citron in Persia and Media, the lemon in Arabia, and the pomelo in the Malay Archipelago. The citron was conveyed to Europe as an article of commerce long before the attempt was there made to grow it, and was supposed to be the fruit of the scented *cedron* wood, hence the name 'citron'. In due course it seems to have been raised from seeds procured from the imported fruits; the lemon next followed, and last of all the orange, while the pomelo, though diffused to India, Ceylon, the West Indies, &c., has not been successfully grown in Europe. Once introduced, the citron, lemon, and orange were rapidly extended, and numerous special races evolved. For several centuries Europe thus obtained its supplies from the warm temperate tracts of its own southern areas, and from the islands of the Mediterranean and Atlantic, adjacent to Africa. But the quicker transit of steam in modern times permitted supplies to be drawn from a greater distance, and hence the West Indies became one of the chief sources for Europe and America. Liability to frost may be affirmed as the one condition that checks extended production, hence the greater success of the West Indies as compared with Florida. In India the oranges and limes perhaps deserve to rank as the foremost of fruits, being second only to the plantains (bananas). The citron and lemon attain their greatest perfection in Spain, Portugal, the Canaries, and the Azores. Sicily supplies, in fact, the largest quantity. Lemon peel (the candied rind), also the essence of lemon, expressed from the rind, and citric acid, prepared from the pulp, are the chief products of these species. In the West Indies (especially Montserrat, Dominica, and Jamaica) the production of lime juice has become an exceedingly important industry. Of oranges there may be said to be two chief kinds, bitter and sweet. The former, known as the Seville Orange, is largely employed in the manufacture of marmalade; the latter is eaten as a fruit. Of the special kinds of the latter, mention may be made of the blood orange of Malta, of the mandarin orange of China, of the loose-jacket oranges of India, of the much-prized oranges of St. Michael, and lastly of the numerous special races of Spain and Portugal. [G. W.]

Cives. See CHIVES.

Cladius padi (the Plum-leaf Sawfly), a black sawfly with two dull white spots on the thorax; white legs with black markings and black tarsi; wings slightly smoky with pale costa; very variable. Three broods are said to occur, in May, June, and September. The eggs are laid below the leaves, and hatch in five to eight days; the young larvæ feed on the under epidermis, eating their way out at the surface; at first they are greyish-green with a reddish tinge, varying to grey, sides pale-green to white, last two segments pale; when older they become green or greyish-green, with almost white sides and apical segments; head pale-orange-brown, with orange and black marks. Larval life lasts three weeks, and they then fall to the ground and pupate in a parchment-like cocoon, from which the second brood appears in nine to twelve days. The second brood occurs in mid June, and from these a third brood may occur in September and October. Like other sawflies, they pass the winter in the larval stage in a cocoon in the soil. Besides plums and cherries, it also feeds on the leaves of pear, rose, hawthorn, bramble, and mountain ash. The damage is done entirely to leaves, which at first have the lower epidermis and mesophyll eaten in small areas, and later holes eaten right through them.

Treatment consists of spraying with hellebore wash or arsenate of lead. Hellebore wash is made as follows: Fresh powdered white hellebore, $2\frac{1}{2}$ lb.; water, 10 gal. (For arsenate of lead, see special article.) The larvæ, especially when rolled up, may readily be jarred off on to tarred sacs. Removal of surface soil in winter is advisable in isolated cases of attack. [F. V. T.]

Clarkia, a genus of hardy annuals of delicate habit, natives of western North America, and allied to our native Willow-herbs (*Epilobium*). Numerous varieties have originated from *C. elegans* and *C. pulchella*, those of the latter being the most generally grown. They comprise tall and dwarf, single and double forms, in a variety of colours. Sowings may be made in spring and in autumn, and the plants should stand 9 in. to 1 ft. apart. [W. W.]

Clary, a South European plant (*Salvia Sclarea*) cultivated for its leaves, which are used in soups, but not held in general esteem. An annual sowing should be made on a warm

border in spring, thinning the seedlings to 1 ft. apart. As they die after ripening seeds, the leaves must be gathered and stored for winter use. [W. W.]

Clatting, the process of removing wool from the udders and tails of pregnant ewes. Keeping the hind quarters clean prevents the cohesion of tufts of dirty wool round the vulva —a condition of things detrimental to the sheep at lambing time. Clatting also prevents the formation of wool balls in the lambs' stomachs. [R. H. L.]

Clay.—The word 'clay' is used in at least three different senses: (1) to denote a clay soil; (2) to denote all the particles below a certain size in the soil; (3) to denote a special substance to which the clay soil owes its peculiar properties. In the present article the word is restricted to the latter meaning.

In order to obtain clay, the soil is washed with dilute hydrochloric acid and then ground up with dilute ammonia; the turbid liquid is poured off and allowed to stand for twenty-four hours in columns 8·5 cm. high (this operation is conveniently performed in beakers), when it is again decanted from the residue. The liquid now contains the clay in suspension, while the sediment, after several repetitions of the process, contains none, and no longer shows the clay properties. On adding a solution of calcium nitrate or common salt, the clay separates out in flocks; these are filtered off and washed free from most of the salt. The substance thus obtained, which we may call Raw Clay (after the German *Rohton*), but which is sometimes called clay (see meaning (2) above), is composed of particles having a diameter smaller than ·002 mm., *i.e.* than $\frac{1}{12500}$ in. (see Soil, Mechanical Analysis of), is light in colour except when much ferric oxide is present, and dries to hard, shining flakes. Its properties, however, are only seen when a certain amount of water is present, particularly if it is well rubbed with the water; it then becomes very sticky, and absolutely impervious to air or water. It is also highly plastic, and can be moulded into shapes which remain permanent on drying and baking; the plasticity is, however, influenced by the presence of other bodies. It shrinks very much on drying, and absorbs heat; when moisture is added the process is reversed, and there is considerable swelling and evolution of heat. It undergoes some change when heated beyond a certain point, and permanently loses its special properties. Addition of acids, salts, or lime also causes most of these properties to disappear, but only temporarily; the substance ceases to be plastic, it becomes permeable to air and water, and it settles quickly when shaken with water: it is now said to be flocculated. The process can be watched if a small quantity of any of these flocculating substances is added to the turbid liquid obtained by shaking Raw Clay with water; the minute particles unite to form larger ones which settle, leaving the liquid clear. There is, however, no permanent change; 'deflocculation' takes place, and the original properties return as soon as the flocculating agent is washed away. No relationship has yet been established between the nature of the agent and the amount of flocculation it will produce. Hall and Morison (Journal of Agric. Science, vol. ii, 1907, p. 244) found that the different acids and salts showed great variations in their flocculating power, but that these variations did not depend on the degree to which ionization had taken place. Acetic acid and the acetates, for example, had much the same value as sulphuric acid and the sulphates, and chlorinating the acetic acid had little effect on the result. The effect depends on the valency of the metal; aluminium sulphate is twice as potent as calcium nitrate, chloride, or bicarbonate, and ten or twenty times as potent as potassium or sodium salts; but no mathematical relationship exists. It thus appears that Whetham's theory that flocculation is an electrical phenomenon is unsound. Alkalis (caustic soda, caustic potash, and ammonia, and their carbonates) have the reverse effect and deflocculate clay so that it remains suspended in water for long periods; the other properties also appear to be intensified.

Raw Clay has the power of reacting chemically with salts. If shaken up with a solution of an ammonium salt an insoluble ammonium compound is formed, and an equivalent quantity of base from the clay goes into solution. It was formerly supposed that acid was set free during the process, but this is now known to be incorrect (Hall and Gimingham, Trans. Chem. Soc., 1907, vol. xci, p. 677), and the action is a simple exchange of bases. Similarly an insoluble potassium compound is formed when a potassium salt is shaken with Raw Clay. The practical consequence of these facts is that soluble potassium and ammonium salts applied as manure do not wash out of the soil, but react to form insoluble substances. Complex organic substances are also absorbed by clay; this property comes into play in the purification of sewage by land filtration, the staining of clay by aniline dyes, and other phenomena.

In chemical composition, Raw Clay is very complex. Loughridge has analysed a sample isolated from a Mississippi soil, and Hall has analysed some from Rothamsted. The results are:—

Loughridge

(using unignited material).

Soluble silica	33·10
Ferric oxide (Fe_2O_3)	18·76
Alumina (Al_2O_3)	18·19
Potash (K_2O)	1·47
Soda (Na_2O)	1·70
Magnesia (MgO)	1·33
Lime (CaO)	·09
Oxide of manganese (Mn_3O_4) ...	·30
Phosphoric acid (P_2O_5)	·18
Sulphuric acid (SO_3)	·06
Insoluble matter	15·96
Water and organic matter ...	9·00
	100·14

Hall

(using ignited material).

Silica (SiO_2)	45·9
Ferric oxide (Fe_2O_3)	12·2
Alumina (Al_2O_3)	30·9

These proportions do not correspond with any simple formula: there is in both cases too much silica for kaolinite.

In the preceding paragraphs we have been dealing with the whole of the material having less diameter than ·002 mm., and have called it Raw Clay in order to avoid committing ourselves to any view as to its nature. There has been a good deal of discussion as to whether it is all true clay or not. Schloesing (Comptes Rendus, 1870) considered that only a small part of it is true clay; he isolated this part by treating with a small quantity of ammonia, diffusing in a considerable volume of distilled water, and leaving for some months till all deposit ceased. The material still remaining suspended in the liquid showed no visible particles under the microscope; it was precipitated by adding an acid, and dried to a translucent, hornlike mass. He called it 'Colloidal Clay', and supposed it to be the true clay. Warington in England, and Hilgard in America, adopted this view; the latter considered colloidal clay to be identical with kaolinite (Soils, p. 59). Williams, on the other hand (Forsch. Agr. Phys., vol. xviii, p. 225), supposed that the whole of the Raw Clay is clay, and this view has been developed by Whitney (U.S. Weather Bureau, Bull. No. 4, 1892). Particles of ·001 mm. diameter, whatever their chemical nature, are supposed to be in continual Brownian movement, and therefore to remain suspended in water, to show adhesiveness, plasticity, and other clay properties in virtue of certain physical forces coming into play when these small dimensions are reached. The experimental evidence, however, is against this view: *e.g.* the loss of the clay properties when the particles have been heated above a certain temperature, and the fact that no one has obtained quartz in a sufficiently fine state to be plastic. However, some, at any rate, of the clay properties are conferred on fine powders when a little alkali, *i.e.* soda or potash, is present, and the writer's view is that the small quantity of alkali set free by hydrolysis when clay is moistened is directly effective in conferring adhesiveness, the power of remaining suspended in water, &c. It can be shown that any treatment known to increase these properties would also increase the amount of alkali present, whilst any treatment impairing the clay properties also decreases the amount of alkali. On the whole, it is most probable that the fine material—the Raw Clay—is a mixture of (1) zeolites, *i.e.* silicates readily entering into chemical reactions and possessing the power of exchanging bases with certain salts; (2) finely divided kaolinite or substances derived therefrom; (3) other finely divided silicates, perhaps also silica; (4) material other than silicates—ferric oxide, alumina, &c.; also some organic matter. The reaction with ammonium and potassium salts may be due to the zeolites; the special physical properties, plasticity, adhesiveness, &c., may be due to (2), or to (1), (2), and (3), or all four groups of constituents acting under the influence of the trace of alkali set free by hydrolysis of some of the silicates. And since these physical properties characterize clay, it is clear that the name 'clay' should be given only to the substance to which they are due. It is just the impossibility in our present state of knowledge of deciding between the rival hypotheses and saying exactly what this substance is, which accounts for the ambiguity of the word 'clay'; each writer uses it to denote the material which, in his opinion, possesses the above special physical properties.

The general effect of clay on the soil is simply to impart its special properties to a greater or less extent. It impedes the movement of water in the soil, so that if its amount is not too great, the rainwater largely remains in the surface layers within reach of the plant roots instead of running through to the subsoil, hence clay makes a soil retentive of water. But when larger amounts are present the passage of water is interfered with too much, so that the soil becomes water-logged in wet weather and parched during prolonged drought, even though the permanent water level is near the surface. Similarly the movement of air is impeded, so that roots in a clay soil get a very limited air supply. The temperature of the soil also tends to be lowered. The adhesive properties of clay cause the soil particles to bind together into those aggregates on which 'tilth' depends; probably no factor is so important in determining tilth as the amount and condition (whether flocculated or not) of clay in the soil. A sand-heap gives a good idea of what soil would be like without clay. When, however, too much is present, the soil becomes more adhesive than is desirable; it sticks to the tillage implements, retarding their movements, and is said to be 'heavy'; it also tends to form large clods quite unfavourable to vegetation. This effect is particularly observed in wet weather; the soil becomes sticky or 'poached', and must not be worked, or the tilth is injured for a long time; cultivation of these soils is therefore rather a delicate matter. In all these ways a certain proportion of clay is highly advantageous in the soil, but too much is detrimental. Another effect of a large amount of clay is to make the soil shrink very much on drying, so that large cracks appear in the fields in summertime. Clay soils always contain a fairly high amount of soluble matter, especially salts of sodium, potassium, calcium, and magnesium, but whether these are to be assigned to the clay or not depends rather on the definition of clay adopted. As pointed out above, clay 'fixes' and retains the ammonia and potash supplied as manure.

The percentage of Raw Clay in different types of soil is somewhat as follows:—

Very light sands	1 to 3.	Clay soils ...	15 to 25.
Sandy soils ...	3 to 8.	Stiff clay soils	25 and over.
Loams	8 to 15.		

It is also necessary to take into consideration the amounts of other constituents, especially the finer grades of silt; of any substance like organic matter or calcium carbonate which tends to flocculate the clay; and of bodies like ferric oxide, which modify its adhesive properties. The amount of colloidal clay in soils was estimated by Schloesing at about 1 per cent.

The fundamental principle involved in dealing with soils containing too much clay is to flocculate and keep flocculated the particles, so that they lose to some extent their special properties. Lime is the most effective agent for this purpose; it has very little action when quite pure, but is rapidly converted in the soil into calcium bicarbonate, which is very potent. Frost also has a flocculating action, perhaps because it facilitates drying of the clay. On the other hand, the particles are rapidly deflocculated, and the texture of the soil therefore injured, if any attempt is made to work it when wet; alkaline manures, like liquid manure, and also manures leaving an alkaline residue in the soil, like nitrate of soda, have the same effect; all these are to be avoided. The scheme of treatment must therefore include drainage to dry the soil, and liming to flocculate the clay; both these diminish the adhesiveness, &c., of the clay. But as the flocculation is only temporary, the improvement only continues so long as any lime lasts or the drains are in good order. Constant watchfulness is therefore necessary, and any process tending to deflocculate the clay—working when wet, or addition of a substance which is alkaline, *e.g.* liquid manure, or gives rise to an alkali, *e.g.* nitrate of soda—is to be avoided.

[E. J. R.]

Clay and Clay Soils.—The term 'clay' is used in several senses, as explained in preceding article, which should be consulted along with this. From a physical point of view there is a general agreement as to what may be called clay, since its plastic properties appeal alike to farmers and ordinary pedestrians. The mineralogist, however, regards clay as a massive, if often impure, kaolin (see art. KAOLIN). Every clay, on the other hand, when carefully examined, is found to contain some quartz sand; and quartz itself, when ground down to a state of extremely fine division, provides a plastic material. Hence we depend for our definition of a clay on the amount of fine material present, *i.e.* material less than ·01 of a millimetre, or $\frac{1}{2500}$ of an inch in diameter, and this is the factor that primarily affects the agriculturist. The natural processes of sifting, however, in running water on the earth tend to carry tiny flakes of kaolin and micaceous minerals to a farther distance from the shores of lakes and seas than is the case with ordinary sand; and hence we find that an appreciable proportion of what we call 'clays', especially among the refractory 'fireclays', consist of some 47 per cent of silica, 39 per cent of alumina, and 14 per cent of combined water, and represent, in fact, the composition of kaolin. As a rule, however, there is too much silica, while the iron oxides present are probably in part combined with silica and alumina in the form of micas, chlorites, and other hydrous silicates, which lessen the amount of true kaolin in the clay. Undecomposed felspars may also be present.

The extreme plasticity of clays seems to depend on the presence of colloid matter, which forms perhaps not more than 1 per cent of the whole. This material remains indefinitely suspended in distilled water, whence it may be precipitated by an acid as a jellylike mass. Thoroughly dry samples of clay fall to pieces when immersed in water, though pressing with the fingers, or any form of 'puddling', soon brings the tiny particles together again to form very plastic lumps. Clays shrink greatly on drying, sometimes as much as 18 per cent, owing to the drawing together of the loosely aggregated particles by the surface tension of the residual water films as the main body of water evaporates away. Cracks thus open in a mass of clay, and enable it to part with its water contents by evaporation far sooner than would otherwise be the case. These cracks also provide drainage passages through the upper layers.

The dark colour of some clays is due to organic matter. A bluish tint is often given by finely diffused sulphide of iron. This oxidizes near the surface, colouring the clay and the soil a characteristic brown.

It is usual for writers on agriculture to classify soils according to the relative proportions of the two ingredients, 'sand' and 'clay', of which most soils mainly consist. They define a clay soil as one containing from 70 to 95 per cent of the latter ingredient; but different writers give different figures. Such a definition is obviously unsatisfactory, unless it is exactly stated what material is to be regarded as clay. The limit ·01 mm. diameter, mentioned above, serves a useful end by enabling us to distinguish between the sandy and the clayey elements of a soil. Particles of the 'fine earth' below ·01 mm. diameter may be considered as clay. This limit is not an arbitrary one, for certain very well marked clayey characters begin to manifest themselves in particles of about this size. On such a basis a pipe clay may contain as much as 96 per cent of clay, and an ordinary clay soil may contain from about 50 per cent of that material. Practical agriculturists describe a clay soil as one that is stiff to work, that holds water on its surface, that, when cultivated in the wet condition, is sticky, polishes after the plough, and dries into a hard brick-like mass.

A soil may be called by geologists a loam, owing to the presence of gritty particles, although farmers, looking at it from a cultural point of view, may still regard it as a clay. Clay soils are either directly derived from clay rocks, or are produced by the rearrangement of drifted materials, or of rock detritus, through the agency of running water, or even of winds. Clay soils are stiff, and difficult to cultivate; they are cold, and often wet, owing to their extremely high capacity for holding water, and because, from their impervious nature, they retain rainwater for a considerable time on their surface. As a rule, these soils are best adapted to pasture, but, when cultivated, they favour the growth of a few farm crops, notably wheat, beans, and cabbages. (See following arts.)

[G. A. J. C.] [T. H.]

Clay Burning consists in the burning of the staple of a clay soil, and is not to be confused with the burning of weeds, or of parings from the surface, with a view to cleaning land. It is also largely used in roadmaking, and espe-

cially for laying a foundation for railways. In such cases the burnt clay resembles brick rubbish and answers a similar purpose, and does not relapse into a plastic condition, but makes a firm and dry bottom. Clay burning in an agricultural sense is less severe, as the heat is regulated so as to scorch the clay and to produce a 'black' rather than a bright-red product, and a mouldering mass rather than a clinking road metal. In all treatises on clay burning for agricultural purposes the reader is warned against a cherry-red or white heat, and is recommended to so regulate the fires as to preserve a low red heat in the centre of the heap, and to foster its dissemination through the clamp by gradual additions of raw clay, and the exclusion of air, except to a moderate degree. It is therefore evident that there is a great difference between burning clay for pottery, bricks, or draining tiles, and burning it as a means of mitigating the adhesive properties of stiff soils. Much skill is required in regulating the heat and causing it to spread equally through a mass of 100 or 200 cu. yd. in a clamp. The operation is carried out in summer when the clay is dry, and the burner accomplishes his object by adding fresh accumulations of clods and fine soil, so as to stifle-burn the mass and, at the same time, keep up the heat to the required intensity. At the commencement, a fire must be kindled with waste wood or slack coal, and upon this the clay is piled until a clamp is the result. Clay is not in itself combustible, but it contains, in agricultural soils, a considerable amount of organic and combustible matter which assists to keep up the heat. Fresh addition of coal may be necessary as the heap extends from the centre, but the heat is never allowed to break through the outside, which remains comparatively cool. It is in fact 'stifle-burning', an expression generally understood by farmers. In order to secure success, the heap is protected by thatched hurdles, when necessary, on the windward side, and fresh clay is added wherever the heat shows a tendency to burst out. The best descriptions of the process are to be found in the early volumes of the Royal Agricultural Society's Journal, and the examples are taken from Essex, Worcestershire, and other heavy clay land counties. Clay burning is one of those enterprises which was more extensively practised when wheat was double its present price, and when good corn crops were worth £12 and £16 per acre. It is probably but little used now, and is inconsistent with laying down clay soils to permanent pasture, or with the present low prices of corn. The names of J. J. Mechi of Tiptree Hall, Essex, C. Randal of Chadbury, Worcestershire, Francis Pym of Caxton, Cambridgeshire, Eli Turville of the Roothings, Essex, bailiff to T. W. Bramston, Esq., were all associated with clay burning. In some cases large clamps are used, and in others smaller heaps, and the duration of the process is in proportion to the size of the clamps. Philip Pusey, the able first editor of the R.A.S. Journal, remarks: 'It is best effected by making heaps of not less than 60 to 100 loads in each, and these will take two to three months to burn'. Mr. F. Pym wrote as follows: 'The work of burning is begun in May and continued through the summer, in heaps containing from 50 to 100 yards each, at an expense of 6*d.* to 7*d.* per yard'. The quantity used varies from 40 to 50 yards per acre, and the improvement lasts from four to eight years. All the authorities agree as to the importance of slow or 'stifle' burning, a moderate heat, and a mouldering 'black' product.

The benefit accruing from the application of burnt clay is very considerable. Mr. Pym put it as high as an increase of 10 bus. of wheat per acre. The effect of burning is to mitigate the retentive character of the soil by introducing into it a mass of material deprived of adhesive properties through the action of heat. The amount of soluble potash, and probably of other mineral salts, is also increased, but it must be allowed that the process involves some loss of nitrogen.

The loss of nitrogen is speedily recouped by heavier root crops, as might be easily shown. For example, in ordinary weed burning, or paring and burning for cleaning purposes, the loss of nitrogen must be considerable; but a good root crop is ensured, and this will be found to have stored up as much nitrogen in its leaves and roots as were dissipated from the burning weeds. The merits of clay burning rest upon experience, but are also capable of scientific explanation. It is one of a class of improvements in which the inherent fertility of the soil is developed without the assistance of extraneous materials, and in this respect it resembles the action of drainage, subsoiling, and good cultivation. It appears to be peculiarly adapted for certain districts and geological formations, such as the plastic clays of Essex, the gault of Cambridgeshire, the lias of Worcestershire, or the great beds known as the London, Kimmeridge, and Oxford Clays. It is rather to be classed as a durable than a permanent improvement, on account of the slow relapse of the burnt clay into its plastic form. Pottery and brick never lose their brittle character, and so far as burnt clay is concerned this would also be true if the heat were carried to a cherry-red pitch. The object, however, appears to be mitigation rather than complete alteration of the texture, and hence the liability of relapse and the necessity of repetition. [J. WR.]

Clay-coloured Weevil. See OTIORHYNCHUS PICIPES.

Claying is akin to marling, and is carried out upon sandy and peaty soils with very great advantage. In South Lincolnshire the fertility of the land around Boston is largely due to heavy dressings of clay dug from below the deposits of black peat, and spread over the surface. Trenches are opened at eight-yard intervals, and the clay, which is the foundation of the peat, is spread on either side, after which the trenches are closed. On the blowing sands of East Essex, in mid-Yorkshire, and in various other districts (as for example at Dirleton, N.B.) clay has been found beneficial in giving consistency to shifting sands in which the particles are carried over the surface by wind, to the destruction of young and tender seedlings. About 40 cu. yd. of clay con-

stitutes a sufficient dressing, which may be applied upon clover land before breaking it up, or upon stubble. The dressing may be repeated if the effect appears to warrant further expenditure.

The effect of claying is both mechanical and manurial (chemical). With regard to the first, it is scarcely necessary to enlarge upon it, but it is noteworthy that a comparatively small amount of clay produces much more effect upon a sandy soil than would a dressing of sand in mitigating the tenacity of a clay soil. This simply means that a small percentage of clay acts as a cement, while a larger quantity of sand is swallowed up by a clay soil, without palpable effect. The manurial advantage is due to the large amount of potash especially, but also of phosphoric acid and lime, contained in natural clays and marls. There are also intermediate effects, which may be called physico-chemical, such as the absorbent powers of clay towards water, ammonia, and fertilizing matter in general; in all of which properties sandy soils are conspicuously deficient. [J. WR.]

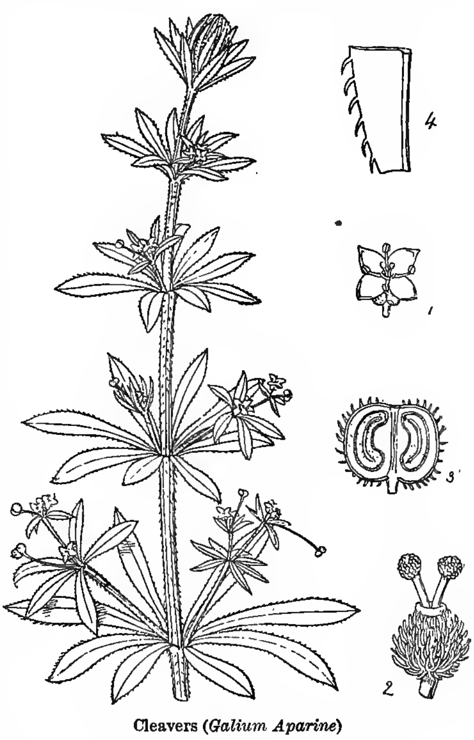
Claystone, an old name for igneous rocks with a dull and earthy ground, which is composed of clayey material. When distinct crystals appeared, set in this ground, the rock was styled Claystone-porphyry. J. Macculloch (Classification of Rocks, 1821, pp. 493 and 509) correctly classed claystone with a number of compact rocks, mostly of volcanic origin. The clayey nature of the ground is now known to be due to decomposition, and the common pinkish tint arises from oxidation of ferruginous minerals. The claystones of old writers are thus altered andesites and basalts, occasionally perhaps verging on the trachytic series. The dark varieties of Macculloch's 'indurated claystone' are compact basalts. Most of these rocks, as their name implies, yield clayey soils, which are distinctly red through the oxidation of the iron compounds. The 'porphyrite' masses of the Ochil Hills and the Lammermuirs, and many areas in the southern uplands of Scotland, contain typical claystones, the soils on which, but for their frequent excessive elevation, would be as fertile as those on basaltic plateaus. These old lavas are sometimes marked by rich grassy areas. [G. A. J. C.]

Cleaning (land) is universally understood to mean the eradication of weeds. 'Clean' in this sense is used in contradistinction to a foul or 'dirty' condition, generally due to couch, thistles, docks, and other perennial intruders. The cleaning of land is a serious expense, as it not only involves eradication, but also maintaining a clean condition. Light lands are more subject to foulness than clay soils, on account of the ease with which couch ramifies through them. Couch is, in fact, the arch-enemy of the arable farmer. It revels in a loose or light condition of soil, and this is shown by its general absence in permanent pastures. Similarly, if once eradicated from clay soils, it does not appear again so rapidly as in light soils. The cleaning of land from couch is best effected by the use of cultivators, whether actuated by steam or horses. Tap-rooted weeds, such as thistles, are more successfully dealt with by deep ploughing. Surface weeds of an annual duration are not as a rule considered to be inconsistent with clean farming, except in such cases as charlock, and other persistent plant pests. Such weeds as redweed (poppy), chickweed, Veronica, fumitory, &c., are always liable to appear wherever crops are thin on the ground, and are best checked by smothering crops and good cultivation. In dealing with surface weeds, hand and horse hoeing are the best means of destruction; but in the cases of foulness due to deep-rooted perennial weeds, fallowing (whether bare or cropped) affords more ample opportunity for cleaning processes. [J. WR.]

Cleansing.—The expulsion of the fœtal membranes or placenta, after the birth of young, is commonly known as cleansing, and is described under AFTERBIRTH, &c. [H. L.]

Clearing of Plantations. See PLANTATIONS, CLEARING OF.

Cleavers (*Galium Aparine*), also known as Goosegrass and by other popular names, is an annual weed belonging to the nat. ord. Rubiaceæ. The stem is weak and deficient in skeleton, yet it can attain the erect position by using the hook prickles with which it is plentifully provided, as organs for clinging to any plants in its neighbourhood. The leaves are narrow and arranged in whorls, usually eight per whorl. The small white flower, when ripe, becomes converted into a two-lobed fruit, also provided



Cleavers (*Galium Aparine*)

1, Flower; 2, Pistil; 3, Section of fruit; 4, Edge of leaf, magnified

with hooks, which enable the weed to utilize passing animals as its fruit distributors. Eventually, the fruit detaches from the animal and reaches the ground, often at very considerable distance from the parent plant. Cleavers is a weed of light land, and is a frequent pest in corn crops. To exterminate it, seeding should be prevented; pure corn, free from cleavers seed, should be sown, and special care should be taken that no cleavers seed gets into the dung. [A. N. M'A.]

Cleft Grafting. See Grafting.

Cleg, Clegg, a name for several species of the blood-sucking Diptera which, by means of their piercing mouthpiece, abstract blood from animals and cause great annoyance to horses and cattle in summer. One of the best known is the *Hæmatopota pluvialis*, a greyish-coloured fly larger than a house fly, which not only annoys cattle in hot weather but often inflicts a severe bite upon a person's face or hands before he is aware of what has happened. Other species of Cleg are *Chrysops cæcutiens* and *Tabanus bovinus*. See Chrysops and Tabanus. [R. H. L.]

Clematis, a large genus of ranunculaceous plants, comprising over 150 species, which are widely distributed in temperate and subtropical countries, the largest number being Asiatic. Most of them are woody climbers, and are hardy in this country, the tenderest being *C. indivisa* from New Zealand. About fifty years ago several species with large handsome flowers were introduced from China, and these were successfully crossed with the species already established in gardens. One of the best of the hybrids thus obtained was *C. Jackmani*, now a universal favourite, growing as it does under ordinary conditions and flowering with the greatest freedom. Many other hybrids, some with much larger flowers than *C. Jackmani*, have been raised in this country, and a selection of them is quite worthy of the little trouble needed to grow them to perfection. They support themselves by means of their twining leaf-stalks, as is seen in the native *C. Vitalba* or Traveller's Joy. Their flowers are peculiar in that the showy portions consist of sepals instead of petals; generally these are flat and spreading like the spokes of a wheel; the *Viorna* section have pitcher-like flowers.

Clematises succeed best in a chalky soil, and although some of them grow well in partial shade they like sunshine, being happiest when trained on trellises, pergolas, summer houses, or on trees, such as old apple or pear trees. There are a few species which have herbaceous stems, but these are not among the most decorative. The following are the best: *C. alpina*, *C. calycina*, *C. coccinea*, *C. florida*, *C. flamula*, *C. Hendersoni*, *C. lanuginosa*, *C. montana*, *C. patens*, *C. Vitalba*, *C. Viticella*, and *C. virginiana*. [W. W.]

Clerk of Works.—To the estate Clerk of Works falls the duty of keeping the buildings connected therewith in proper order. He is of necessity an architect by training; at any rate he must be so far proficient in draughtsmanship and in the principles of building construction as to be able to prepare plans, specifications, and bills of quantities, and to this he can hardly otherwise attain than by a course of longer or shorter time in an architect's office. He is called upon to turn out all sorts of plans, from those relating to farmhouses (it may be for additions to the estate mansionhouse) to plans of such seemingly non-important places as ashpits and liquid-manure tanks. It is well when his tastes are somewhat in sympathy with country pursuits, for then he will be better able to adapt the farm buildings to the requirements characteristic of the district in which he happens to be placed. There is of course the probability that the agent in charge will keep him right in this connection. The inclusion of this official on the management staff implies a fairly large estate. As estates diminish in extent do we begin to find the Clerk of Works being obliged to take up other work than the provision and supervision of buildings. In all instances he is responsible for the sanitation of the buildings. But as his sphere of action becomes narrowed, and the buildings alone are not sufficient to occupy his time fully, the oversight of the various water supplies may be put his way. He may be made responsible for the upkeep of the roads too. Rarely are the fences put under his care; seldomer are the field drains. But once a certain size of estate has been reached we see the contrary process of other estate officials usurping the duties of the Clerk of Works going on. The bailiff or land steward may be given the work he has to do. There may be an assistant agent or an under factor, according as the estate is an English or a Scottish one, on whom it may fall; or the agent himself may have sufficient time to take the duties upon himself. Under any conditions, however, the work passes under the agent's cognizance. On the ordinary Irish estate there is, we need hardly say, no room for this official. [R. H.]

Cletch, Clutch, a brood of young chickens, ducks, geese, &c.

Cleveland Bay. — It can scarcely be claimed for the Cleveland Bay horse—the name is derived from Cleveland in East Yorkshire—that he belongs to a variety which is as widely bred as formerly. This observation unfortunately applies to other breeds of harness horses, the demand for which has of recent years been in inverse ratio to the popularity of the ubiquitous motor car; but on the other hand there is consolation to be derived by the horse breeder from the knowledge that there are certain duties which it is impossible for the motor to fulfil, but for which the equine race are perfectly qualified. It is impossible, for instance, to conceive long lines of motor landaus slowly parading Hyde Park on a summer afternoon during the height of the London season, or a procession of such vehicles taking part in such ceremonies as the opening of Parliament by His Majesty the King. The horse, however, adds immeasurably to the picturesqueness of such functions, and none more so than the Cleveland Bay, a variety which by its stature and imposing appearance is admirably adapted to adorn the equipages of the wealthy. The position now occupied by the

Photo. Sport and General Illustrations Co.

CLEVELAND BAY—"SPECIAL LIGHT"

WINNER OF 1ST PRIZE AT R.A.S.E. SHOW, 1907

breed and the consideration of its conformation and peculiarities may be deferred until some light has been thrown upon its origin and history, for the Cleveland is a horse which was extremely valued by the British public in days gone by; and most probably, let it be added, more prosperous times may yet be in store for a thoroughly reliable and very handsome member of the equine race.

As in the case of most, if not all, of the varieties of British horse, a certain amount of dubiety overshadows the origin of the Cleveland Bay. At the same time it is as certain as anything can reasonably be that one of the original taproots of the breed was the Old English War Horse, which in its turn, as is shown elsewhere, was an enlarged and improved edition of the horses of the ancient Britons. It is, however, totally unnecessary to go so far back as the chariot horses of Boadicea when attempting to trace the genealogy of the Cleveland Bay. It will in fact be amply sufficient for our purpose to accept the horse of the Elizabethan period as one of the main sources of the breed, and to endeavour to trace out the evolution of the subject of this article from the period in question. Beyond all doubt it is a fact that during the reign of Good Queen Bess the vehicles of the wealthier classes were built upon far lighter lines than had previously been the case, the credit for the innovations which were introduced being due to the observant faculties of the then existent Earl of Arundel. The highroads of England were becoming better in those days, and as a consequence it was possible to use a less cumbersome vehicle for the purposes of passenger traffic. Hence the ponderous horses which were serviceable enough for heavy draught were found to be too slow and massive for the requirements of the aristocracy. The natural result of this change of fashion was a desire to produce a more active and elegant breed of horse for work in the improved carriages, and as it is an unquestionable fact that there were Eastern horses—Arabs and Barbs—in the country at the time, it may reasonably be assumed that their services were utilized for the purpose. It can scarcely be contended, however, that the animal produced by this means was the original Cleveland Bay. On the contrary, there are grounds for believing that the result of the Eastern–War Horse cross was far more probably the variety which came to be known as the Pack Horse or Chapman's Horse, which was to be found in every part of the country 300 years ago. This breed, of course, was crossed and recrossed in various ways, and naturally with varying results, the most successful of which were probably to be met with in Devonshire and Yorkshire.

There can be little room for doubting, too, that thoroughbred blood entered largely into the composition of the original Cleveland Bay, for a very popular sire named Old Traveller, who used to serve in the Yarm district of Yorkshire about the middle of the 18th century, was most probably instrumental in establishing the breed as we know it. The Old Traveller in question was undoubtedly a thoroughbred, and the name of such a sire appears in many of the oldest Cleveland pedigrees which have come down to us, though it is impossible to assert with confidence that he is identical with the blood horse of the same name. It is, however, quite reasonable to infer that it was so, as it would be a most improbable coincidence that two horses bearing the same name should be serving at the same time in the same district, whilst still more is it unlikely that a fashionable sire, such as the thoroughbred Old Traveller undoubtedly was, should be ignored in favour of an animal concerning whom there is nothing to be ascertained. Since the days of Old Traveller the records of the Cleveland Bay have been more carefully kept than formerly, but still the breeders of the 18th century cannot be exonerated from the charge of having displayed a good deal of carelessness in tabulating the pedigrees of their horses. In this respect they were not more remiss than the raisers of other varieties of stock, as there was a very general disposition to omit conveying details to writing, and hence the obscurity that is associated with so many pedigrees. The breeders of more recent times have incurred no such reproach, however, and thanks to the efforts of the members of the Cleveland Bay Horse Society, the secretary of which is Mr. Thos. Curry, jr., Norton Carr, Nunthorpe R.S.O., Yorkshire, it is now possible to trace the breeding of most, if not all, of the leading horses of the day for many generations.

Before proceeding to the consideration of the points of the modern Cleveland Bay, a few lines may be devoted to a description of the horses of the not remote past, such as for instance those which existed a hundred years ago, by which time the breed was well established as a recognized variety. The Cleveland of those days was undoubtedly a heavier horse than he is now, as he was a good deal used for agricultural purposes by the farmers of the period. This fact, however, does not necessarily prove that he was a 'heavy horse' in the modern acceptation of the expression, as the term now denotes a bulky draught horse of the Shire, Clydesdale, or Suffolk type. Oxen as a matter of fact were generally employed to perform the heaviest work upon the farm; but still there can be very little room for doubting that the old Clevelands were a good deal coarser than they are at present. This contention is justified by the action of the breeders of those times, when they evolved the Yorkshire Coach Horse from the Cleveland Bay in furtherance of their desire to produce a lighter stamp of horse.

The three most conspicuous families of Cleveland Bay a hundred years ago were the Dart, the Barley Harvest, and the Hob Hill Horse. Of these there is little or nothing known of the first named, and he is indebted for much of his reputation to a son named Agars Rainbow, and also referred to as King George the Fourth. A good deal of obscurity is likewise attached to this animal, and even the editor of the Cleveland Bay Stud Book found it impossible to ascertain the date when he was foaled; but regarding his merits as a sire there can be no two opinions. The sires Barley Harvest and

Hob Hill Horse were both foaled just before the close of the 18th century, and from them many an excellent modern Cleveland Bay has sprung. Probably, moreover, their services to the breed to which they belong would have been still more generally appreciated were it not the fact that many of their descendants were crossed with cart horses about the year 1827, the object of the breeder who made the experiment, Mr. J. B. Lloyd, being to produce agricultural horses with 'more activity and little or no diminution of strength'. At least the above is the statement which he made in the Journal of the Royal Agricultural Society; but the experiment does not appear to have been associated with success, as there is no record of the example having been imitated, though we cannot help believing that many of the undesirable crossbreds were subsequently palmed off by unscrupulous or ignorant persons upon an unsuspecting public and bred from, to the injury of the real Cleveland Bay.

The merits of the breed, however, ensured its popularity, until the railway companies extended their systems in parts of the country which had formerly only been traversed by horse-drawn vehicles, and then the Cleveland, like his near relatives the Yorkshire Coach Horse and the Hackney, commenced to languish through lack of adequate support. It was not, however, until well on in the 'sixties of the past century that the fortunes of the variety became really seriously depressed; but even in the very darkest days of his fortunes the Cleveland Bay was fortunate in retaining the support of many loyal friends, and there is satisfaction in adding that these found their reward when more prosperous times returned for the horse of their affections. This was in the year 1884, when it was decided to publish the first volume of the Cleveland Bay Stud Book, and beyond all doubt the appearance of this volume proved most beneficial to the breeders of this class of horse. The fact remains, however, that for years past the breeders of the Continent had been steadily appropriating most of the best Clevelands with the object of improving their own studs by the application of judicious crosses, the result being that the market for big, good-coloured, high-class harness horses adapted for landau and similar work was well supplied with Continental-bred animals. The competition from abroad was, and is still, found by the breeders of Cleveland Bays to be a most serious menace to their success, and it unquestionably has assisted in reducing the number of studs. The fact, too, that there are comparatively speaking few breeding establishments ensures that the number of exhibitors who show Cleveland Bays is also limited, and hence a valuable advertisement is lost to the variety, and the prospects of chance purchasers being found are lessened.

This circumstance, however, does not detract from the merits of the Cleveland Bay, than which no horse is better adapted for very heavy harness work. He may not possess as much quality as his relative the Yorkshire Coach Horse, and certainly he lacks the brilliant action of the Hackney; but in his proper place—that is, in front of a nobleman's state coach, or in a heavy landau in the Park—his claims to recognition are unassailable. No doubt the plainness of his head is calculated to lose him admirers amongst the public, but in most instances he carries it well, and it is nicely set on. His neck is usually good, being gracefully arched and in correct proportion to his body and head; whilst his shoulders, a matter of comparatively minor importance in the case of a harness horse, are for the most part of good length and well laid back. Of course a sloping shoulder is to be preferred to a straight one in all horses excepting the very heavy draught varieties, but unless the animal is required for saddle purposes or for breeding hunters—as the Cleveland Bay occasionally is, though he is not peculiarly well adapted for either object—there are other points connected with his conformation which are more worthy of consideration.

The Cleveland should be a big horse behind the forearms, with a wide chest and deep through the ribs, whilst his back is short, his middle well ribbed up, and his quarters long and straight, with the tail set on high. With so much weight to carry, it necessarily follows that his legs and feet must be of the best, the former being short and well furnished with flat bone, the gaskins being muscular, and the pasterns sloping and of fair length, so as to reduce the chances of concussion. Considerable importance also should be attached to the feet, which to do their work properly must be of a good size, and truly formed, odd feet being a very bad fault; whilst the knees and hocks should also be large, and the latter quite free from blemish. The average height is about 16 hands 2 in., but bigger horses are of course to be found, and these naturally command higher prices, as they create a more imposing display in harness. As a mover the Cleveland Bay cannot aspire to the brilliancy and dash of the Hackney, but a good one should always show plenty of movement for so big a horse; and many a specimen of the breed is a fine goer in front, using his shoulders well, but on the other hand the hock action is often deficient.

Last comes the all-important question of colour, which is unquestionably the greatest characteristic of the breed. This must be bay—no other colour is recognized in the breed, but the shade may be either light or dark, but bay it must be. White markings on the heels or a blaze on the face are most strongly objected to, in fact they are regarded as disqualifications by many authorities, and even a small star on the forehead, though it may be tolerated, is cordially disliked. The legs should be black up to the knees and hocks, and of course the mane and tail are of this colour, and there is very often a dark stripe along the back. This 'list' or 'eel mark' is much liked by some breeders, who regard it as a proof that its possessor traces back to the best horses of the past; but on the other hand, countless admirable Clevelands are entirely without it. A few specimens of the breed, moreover, are to be found which show distinctly defined dark zebra-like stripes upon the thighs, and these are also welcomed by many supporters of the variety.

Of late years the exportations of Cleveland Bays for breeding purposes in large numbers from this country have not been very numerous, but apart from those which went to the Continent, a good few of them found their way to America some years ago. It must be admitted, however, that they did not meet with an enthusiastic reception across the Atlantic, which is scarcely surprising, as a fast, active horse is mostly in favour in fashionable circles there. The experiments, moreover, which were made in the direction of crossing them with the Hackney and Trotter were not particularly successful, and hence the breed lost ground in favour of the Yorkshire and French Coachers, of which the latter is a favourite in the United States.

As regards the market value of this horse, it may be said that a well-matched pair of geldings possessed of size and action are worth a great deal of money, as much as a thousand guineas having been paid for such. Excepting under such exceptional conditions the price is considerably less, for, as observed above, the Continental dealers have invaded the British market with considerable success, and have in consequence reduced the profits of many a north-country breeder.

Happily, however, there have remained some staunch supporters of this fine old English breed, and it is to be trusted that their ranks will be increased by eligible recruits. Comparatively few south-country breeders have cultivated the variety; but it may be added that Mr. Burdett Coutts, M.P., gave the breed a good trial at his Shenley Stud a few years ago, amongst his horses being the well-known sire Sultan, who possessed the unique distinction of being registered in the stud books of both the Cleveland Bay and Yorkshire Coach Horse Societies. [V. S.]

Click Beetle. See Agriotes lineatus, &c.

Clicking, Clacking, Forging.—These terms are variously employed to denote a defect in action, by which the toe of the hind foot, or the parts immediately to one side of it, strike the under surface of the corresponding front shoe when a horse is moving at a pace faster than walking. Many horses do it only when pushed, or exerting themselves beyond a fair pace, but it is a frequent defect in young and imperfectly conditioned animals, who later on grow out of it with the acquisition of further strength and development. Shortening of the toe of the hind shoe, and perhaps a modification of the front one, may overcome the difficulty, but an animal with this propensity should always be ridden or driven under his best pace, or as horsemen say 'collectedly': never extending himself to his fullest. See also Brushing and Interfering. [H. L.]

Climate. See Meteorology.

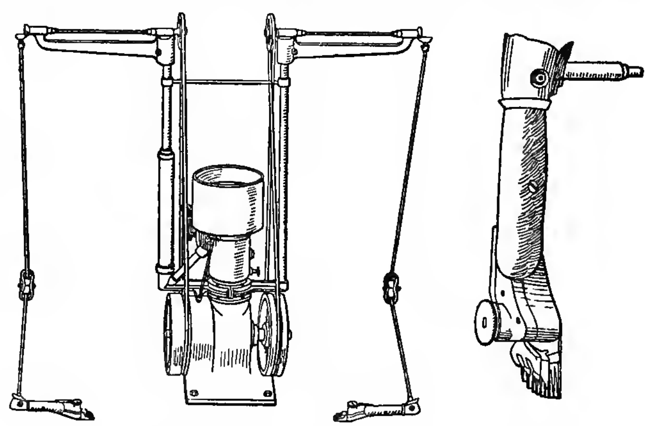
Climbers.—Plants with stems are either self-supporting, or they creep along the ground, or they raise themselves by twining spirally around other bodies, or by means of tendrils or suckers which fasten on to sturdier plants, and thus are enabled to grow to a considerable length in the direction of light. This climbing or scandent habit is useful in horticulture, plants possessing it being employed for clothing buildings, as screens, or for training over pillars and pergolas. Familiar examples are Ivy, Virginian Creeper, Passion Flower, Wistaria, Clematis, bindweeds, Sweet Peas, Scarlet Runners, Hop, and Grape Vine. [W. W.]

Clip-fork. See Elevator.

Clipping, a term applied to the operation of cutting plants into some particular shape. The clipped Yew and Box are not uncommon features in oldfashioned gardens; Hollies also are frequently clipped to form either pyramids or half spheres. Only those plants that produce lateral shoots readily will bear this treatment. It is not so common an operation in English gardens as it used to be, but in Italy and Holland it is very largely practised. Japanese gardeners also resort to a similar process for the production of their grotesquely-shaped trees. [W. W.]

Clipping. See next two articles, also Sheep-shearing.

Clipping Machine.—The clipping machine is an adaptation of Clarke's original hand horse clipper, which embraced the principle of cutting employed in the mowing machine. The mechanical horse clipper differs from the sheep clipper only in that the one is adapted to cut short hair and the other long wool. The clipping machine has greatly facilitated the work in the stable, but its great value lies in the ease and rapidity with which large flocks can be freed of their wool. Moreover, while it took a considerable time for an inexperienced hand to become a capable shearer, the handling of the clipper is soon learned, and a comparative beginner can be trusted to take off the wool cleanly and unbroken, and without cutting the skin;



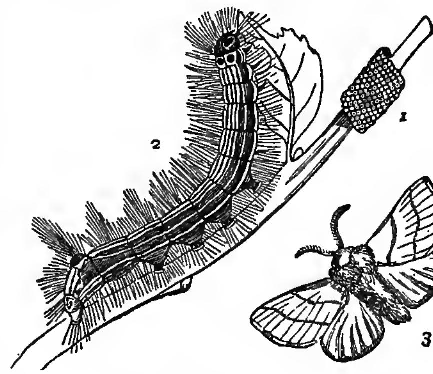
Cooper's Shearing and Clipping Machine, driven by 2-H.P. Petrol Motor

his whole attention can be bestowed on the holding of the sheep, and keeping the clipper up to the wool. Although only a few years ago it was held that the use of the clipper would be confined to the great sheep countries south of the Equator, the perfecting of the machine and the application of simple driving power have so increased its popularity that it is fast superseding the ordinary shears in the British Isles. Many efficient machines are now made, all of which employ the reciprocating principle of cutting. Within the past fifteen years much has been done to add ease and efficiency to the working, the violent vibration and liability to heating having been practically done away with. The introduction of a ball race between the upper and lower plates of the clipper head as a means of minimizing the liability to heat, for which the Barton Gillette Co. were awarded the silver medal of the R.A.S.E. at the Maidstone Show in 1899, marked a great advance, the value of which is appreciated when it is remembered that it is necessary for the knives to make 3000 reciprocating strokes per minute, and that it is only by the application of the best principles that the friction can be so reduced as to allow the clipper to run cool. The smoothness which would be obtained from a rotary knife in the place of the reciprocating one cannot be secured, as, without the momentary stop attained by the reciprocation, the knives would not clear themselves. Motion is given to the shears by means of a core passing inside a flexible tube or shield attached to gear driven by any convenient power, the principle being practically the same as that which suffering mankind witnesses when placed in charge of the dentist. The number of clippers which can be worked at once is limited only by space and driving power; twenty or more are not uncommon on large shearing stations, where an overhead main shaft driven by steam or other strong power permits gearing to be attached where desired. Oil engines are very popular as a driving power, as no stoking is required. Hand or pedal-driven power is used where one or two clippers are worked. A sheep may be shorn in two minutes, but, as with hand shears, the size of the sheep and the closeness of the wool much influence the speed of working. [W. J. M.]

Clipping of Horses and Cattle.—Only heavy draught horses employed at a walking pace can be allowed to retain their thick winter coats, and these are sadly incommoded in mild or 'muggy' weather, when it is almost impossible to dry them if wet with sweat or soaked with rain. Light horses when clipped are capable of greater exertion and faster paces, and prove altogether more efficient. They do not suffer from exposure to the cold so long as they are in motion, or until compelled to stand about without clothing; the latter being made to supply the place of the natural coat in the stable, and sufficing even for the cab horse standing for hours on the rank. Recently clipped horses should be clothed, both for warmth and to prevent the too rapid growth of the hair again, and they should be kept moving by the owner's instructions if compelled to wait about in cold or wet weather (see CATARRH). Hand clippers are commonly used in the single-horse stable, but the work is much more quickly performed by power machines, of which there are many upon the market. The custom of leaving the legs of hunters and some other horses unclipped is recommended as a preventive of mud fever and cracked heels. Cattle of long-haired breeds, when put into byres or boxes to fatten, are very apt to perspire profusely and to lose some weight in doing so. To prevent this, the hair of the neck, back, and shoulders is frequently clipped by hand, and the animals are thus rendered more comfortable and thrive better. [H. L.]

Clips (on Shoes). See SHOES AND SHOEING.

Clisiocampa neustria (the Lackey Moth).—The Lackey Moth caterpillars are often very harmful to fruit and forest trees. Apple,



Lackey Moth (*Clisiocampa neustria*)

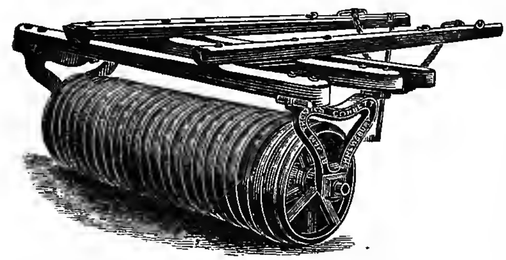
1, Cluster of eggs. 2, Caterpillar, about one-third longer and wider than nat. size. 3, Moth.

cherry, plum, and pear suffer most. The moths appear in August; they are reddish to yellowish brown, with two pale or darker transverse lines on the front wings, densely hairy thorax and abdomen; wing expanse of female 1 to $1\frac{1}{2}$ in., of male 1 in. The eggs are laid in bands around the year's growth of wood, and hatch in April and May. The caterpillars form a tent of silk, beneath which they live until nearly mature, when they wander over the trees. They are bluish-grey, with orange, white, and red stripes with rusty hairs, and reach $1\frac{1}{2}$ in. By July they are all mature, when they spin a white cocoon of silk, with scattered hairs and a yellowish powder, amongst leaves, twigs, &c., and then change to dark-brown pupæ. They do not occur farther north than Yorkshire.

Treatment consists in pruning off the egg-rings in winter and destroying them, and early spraying with arsenate of lead; also the collection of the tents towards evening. [F. V. T.]

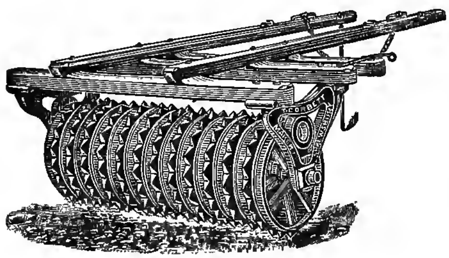
Clod, any hardened lump of earth, or a mass of roots with earth adhering. The cultivation of even a comparatively 'light' soil when wet is liable to be attended with the formation of clods, which are difficult to deal with afterwards. Sometimes they set so hard that they have to be broken down with wooden mallets.

Clod Crushers. — Clod crushers usually take the form of serrated rollers, though an ordinary plain cylindrical roller is a clod crusher. Clod crushers are used for a variety of purposes, primarily to break down large clods to allow the weather to exercise a mellowing influence



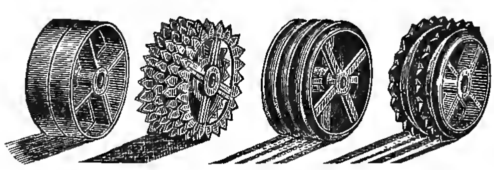
Cambridge Clod Crusher

on them, so as to produce a fine seedbed; but they are also used to tighten the soil about the roots of young crop plants, so that the moisture about them may be retained at times when drought or a coarsely prepared seedbed have allowed moisture to recede from the surface so



Notched Clod Crusher

as to endanger the life of the plants. For a somewhat similar reason, crops infested with wireworm, surface grubs, and other insects are benefited by the tightening of the soil about the roots. Few insects are killed by crushers, but they tend to re-establish plants. As a means of breaking the hard winter cap formed



Segment Crosskill Cambridge Corbett

Sections of Clod Crushers

on wheat land on binding soils, clod crushers have a special value, and allow harrows following to form a soil mulch, which they otherwise could not. Crushers with serrated or notched sections are more effective than smooth cylinder rollers on grass land, since the latter, while giving a beneficial tightness to the soil, often cause it to become smooth and glazed when rolled in wet weather in the spring, and so allow harm to be done if a drought sets in. The harm done in this way is much more common than is commonly supposed. Clod crushers ordinarily are made up of a series of sections strung on to an axle; these sections vary much in size and shape, and much more play about the axle (so as to allow the sections to adapt themselves to the inequalities of the surface) is given in some types than in others. The typical clod crushers are Cambridge's, known as the Cambridge roller, in which a number of sections with a raised rib have a cutting and pinching effect on the soil; and the Crosskill, in which the sections, instead of forming a continuous rib, are notched so as to form numerous points to attack the clods. Combinations of these also make very effective clod-reducing implements; and there are other modifications in the shape of the notches, which are useful, but possess no strikingly marked improvement on the originals. Another form of clod crusher consists of a frame carrying a number of blades so arranged that they slice the clods, but as a rule the rotary form of crusher is preferred. Much heavier clod crushers, with deeper V-sections, were made some years ago, but the lighter forms are found more generally useful; in fact, since dead fallowing has become less frequently practised, the digging plough has come into more common use, and the springtine cultivator has revolutionized the working of land, there is rarely the need for heavy clod crushers, and the type of ring-roller or clod crusher described above best answers the ordinary purposes of the farm.

[W. J. M.]

Close Time. See Game Laws.

Clotted Cream. — The 'clotting' — or thickening—of cream by means of heat applied underneath pans containing it, has been practised a long time in Devonshire, the product being either sold or used in buttermaking. The milk, coming direct from the cows to the dairy, is put into milk pans for creaming, and stands at rest until the next milking time approaches. The pans containing it are then placed in a circular boiler containing water kept at boiling-point by fire underneath. The pans either float in the boiling water or are suspended in it, or else an apparatus specially designed to accommodate a pan is used. In this last case the pan fits the top of the boiler, and there is a tap through which the hot water can be drawn off, if need be. In some dairies the pans are placed on the boiler at once, when the milk comes in from the yards, but the fire is not lit until the usual time has passed, allowing the cream to rise. The cream itself is not allowed to boil, though the milk on which it lies is not far from boiling-point. When the first air-bubble appears on the cream, the pan is at once removed from the boiler and store, and remains at rest for twelve hours longer, at the end of which time the cream is found to be thick and clotted. It is then removed in square or oblong pats about an inch in thickness, packed neatly in bright, clean straw, and sent to market. It is a cream cheese

in all essentials except that of ripeness, and is highly esteemed as a dainty and withal a substantial article of food. [J. P. S.]

Clotting of Blood. See BLOOD and BLEEDING.

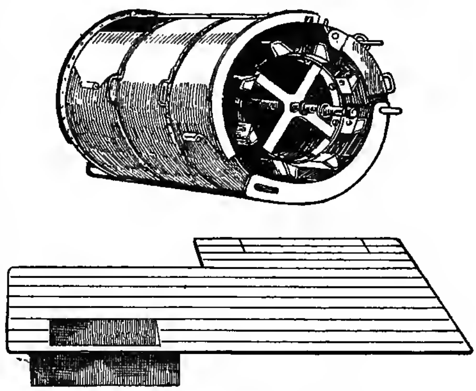
Cloudberry (*Rubus Chamæmorus*) is a dicotyledonous plant belonging to the nat. ord. Rosaceæ, and to the same genus as the well-known Bramble. It grows in turfy bogs, generally in high latitudes. The Cloudberry is an erect perennial herb about 6 in. high, and unlike its allies, not a prickly shrub. The flower is white and solitary, and when ripe it becomes transformed into an orange-coloured fruit, which, like that of the Bramble, is an aggregate of little drupes. The Cloudberry is the badge of the clan M'Lean. [A. N. M'A.]

Clouded-yellow Butterfly. See COLIAS EDUSA.

Clove and the Clove Trees.—Cloves are the dried flower-buds of *Eugenia caryophyllata* (formerly known as *Caryophyllus aromaticus*), a small tree belonging to the Myrtaceæ. Originally a native of the Moluccas, it is now grown in most tropical countries. The name 'clove' (*clou* French and *clavo* Spanish) is derived from the Latin *clavus*, a nail, the round unexpanded flower embraced by its four sepals being the head, and the tapering stalk or undeveloped fruit the stem of the nail. When the stalk is allowed to mature into a succulent purple-coloured berry, containing one or two seeds, it is called the 'Mother Clove'. The Dutch (with a view to secure a monopoly in the supply) endeavoured to exterminate the tree from all the Moluccas or Spice Islands except Amboyna, where the cultivation was carefully guarded and excess crop destroyed. But in 1770 the French succeeded in conveying it from Ceram to Cayenne. In a remarkably short time thereafter the tree was carried throughout the Tropics, and in due course established in Pemba, Zanzibar, and the West Indies (Grenada).

The seeds (or layerings) are sown in a nursery of rich mould, and when the plants are 4 ft. high they are transplanted at the beginning of the rains into their permanent positions, 20 to 30 ft. apart each way. The young plants require to be shaded during their first two years, and the soil must be porous and well drained. The tree prefers confined valleys, and does not succeed well if exposed directly to the sea-breezes, and moreover protection from high winds is essential in order to safeguard the cloves from being blown off and thus lost. By the sixth year the plants begin to give a crop, and by the twelfth are in full bearing. They continue to yield until they are twenty to twenty-five years old, though they may give a crop till they are 150 years old. Each plant should afford from 6 to 7 lb. of dry cloves. The best course is to hand-pick the trees just as the clusters of buds upon the ends of all the branches are attaining a pink colour. They are sometimes caused to fall from the trees by beating the stems, and are then caught in a cloth spread below for that purpose. If fine weather prevails they are next sun-dried, but in cloudy weather are often dried over a shallow fire, and thus smoked. Occasionally they are scalded in hot water preparatory to being dried. The crop loses about 60 per cent in drying. Pemba and Zanzibar yield four-fifths of the world's present-day supply, the bulk of which is exported to Bombay and largely reshipped to the Straits, China, &c.; fair quantities also go direct to Britain, Germany, Holland, &c. [G. W.]

Clover Huller, or **Clover Seed Rubber.**—The clover huller is used to rub out the seed of clover from the heads or 'cob'. Clover is usually threshed in the ordinary corn-threshing machine, and the cob, consisting of broken heads or seed pods containing the seed, which the threshing machine has little effect upon, comes out of the machine at the chaff hole and is passed through a separate machine, the rubber, to clear it from the chaff or pod, though there



Clover Shelling Drum and Feed Hole

are now machines which effectively perform the work of threshing and rubbing both. The older machines consisted of a long conical core of wood, on which deep helical worms were cut and faced with steel; this worked in a suitable concave, and driven at high speed rubbed out the seed without crushing it. These machines were fitted with a fan and sieves to take out the rubbish; the feeding was performed by hand, the attendant shoving in the cob so as to keep up a constant feed. More modern machines work in a very similar manner, but in the place of the wooden core an iron spindle runs through the concave, and to the spindle are attached radial arms which support grooved steel worms; the rapid revolution of the worm causes the cob to fly from the centre, so that the rubbing is effected between the worm and the concave. In recent years, however, machines have been introduced, and found to work satisfactorily, in which the whole process of threshing and rubbing, with subsequent cleaning, is performed. There is a marked advantage in the combined machine, as when the cob is independently treated it is usually necessary to store at any rate a portion of it, with the result that it becomes consolidated slightly, causing fermentation, which even in the smallest degree tends to make the rubbing less effective. Cob should

CLOVERS

1. Alsike Clover (*Trifolium hybridum*); 2. Crimson Clover (*Trifolium incarnatum*);
3. Red Clover (*Trifolium pratense*); 4. White Clover (*Trifolium repens*).

never be subjected to pressure, nor stored in thick heaps. If possible, only frosty or very dry weather should be used for threshing or rubbing, as in dull or damp weather it is very difficult to free the seed from its small pod.

[W. J. M.]

Clovers.—In agriculture this name is used sometimes in a wide sense, to signify leguminous plants in general, and sometimes in a narrow sense, to mark off those species of leguminous plants which belong to the genus Trifolium. For example, when a farmer speaks of Yellow Clover he often means *Medicago lupulina*, which is a Medick. Again, Bokhara clover is not a clover but a Melilot, namely *Melilotus alba*, and Soola clover is a Sainfoin, namely *Hedysarum coronarium*. In this article the word 'clover' is used in the narrow sense for species of the genus Trifolium.

The Clovers are easily distinguished from their nearest allies by attention to the two following points: (1) The blade of the leaf is composed of three distinct pieces or leaflets. In abnormal cases four leaflets may occur, as in Four-leaved White Clover. (2) The corolla of the flower persists in a withered condition, and gives the fruiting head of the clover that bedraggled appearance with which we are all familiar. By this mark we can know at once that Yellow Clover (*Medicago lupulina*) is not a clover at all, for the black kidney-shaped fruits are perfectly visible and bare, a sign that the corolla has not persisted, but fallen away. In pasture it is easy to distinguish the three common forms of clover, namely Red, White, and Alsike, by the following leaf characters:—

The Red Clover leaf-blade is covered with hair; the other two clovers have bald skins.

The White Clover leaf-blade is quite glossy on the under surface.

The Alsike Clover leaf-blade is quite dull and white on the under surface.

It is also easy to distinguish the leaflet of a clover from the leaflet of a Medick (Medicago). At the point of a Medick leaflet there is a notch, *and a small prong projects from the notch.* There is no prong from the notch of a clover leaf. Again, it is perfectly easy to distinguish the leaf of a genuine Cow Grass (*Trifolium medium*) from that of those varieties of Red Clover (*Trifolium pratense*) which are sold in commerce as 'Cow Grass'. For this, the point to attend to is the pair of winglike outgrowths from the base of the leaf-stalk, *i.e.* the stipules of the leaf. In genuine Cow Grass the stipules are narrow and green, with a long narrow point. In commercial Cow Grass, *i.e.* Red Clover, the stipules are broad, light-coloured, almost white, and have quite a short point. In these light-coloured stipules a network of dark veins is very prominent against the light background.

When the clovers are in flower they are distinguished thus by the characters of the flower-heads. Red Clover has a roundish head with red colour, situated at the apex of the leafy stem. Alsike Clover has a head chiefly white, but partly red, which is situated at the end of a long naked stalk (peduncle), springing from the angle between the upright stem and the green leaf. White Clover has a white head of flowers, situated at the end of a naked stalk (peduncle), which springs from a stem creeping along the surface of the ground. Crimson Clover is at once known by its crimson flowers, which are arranged in the form of a long head (spike).

A clover seed is composed of a seed skin containing an embryo plant within. The embryo does not lie straight within the skin, but is so doubled up that its radicle part lies against the edge of the cotyledons. Because of this bend of the embryo, the outside of a clover seed shows a ridge, which is stout and broad if the radicle within is broad, thin and narrow if the radicle is narrow, long if the radicle is long, and so forth. By attending to the features of the ridge, the colour of the skin, and the size, the various clover seeds may be distinguished. The colour referred to is that of the seed at maturity.

Red Clover Seed.—The ridge is stout, blunt at the point, and about half as long as the body of the seed. The skin is glossy, dark violet at one end and yellowish at the other. The size is usually 2 mm. long by $1\frac{1}{4}$ mm. broad.

Alsike Clover Seed. — The ridge is stout, rounded at the point, and about three-quarters as long as the body of the seed. The round point of the radicle spreads away from the body of the seed, and so the form is that of a lop-sided heart. The skin is glossy, of an olive colour, marbled with dirty spots. The size is 1 mm. long by 1 mm. broad

White Clover Seed.—The ridge is stout, and as long as the body of the seed. Its tip is rounded, and so the form is that of a heart, but not lop-sided. The skin is glossy and yellow. The size is practically that of Alsike.

The quantity of clover seed required for sowing an imperial acre is as follows: Red Clover, 16 to 24 lb. of pure germinating seed; Alsike Clover, 9 to 13 lb. of pure germinating seed; White Clover, 8 to 11 lb. of pure germinating seed. The object of cultivating clover may be: (1) to produce either green forage or clover hay, (2) to yield pasturage in grass mixtures, (3) to secure seed, and (4) to enrich the land. Land enrichment by means of clover-growing is associated with a certain root peculiarity. The roots bear numerous special swellings called 'tubercles' or 'nodules', which contain special bacterial organisms in their interior. These organisms have the gift of absorbing elementary nitrogen from the soil atmosphere around, and of transforming it into a combined form of nitrogen. Thus it comes to pass that clovers can thrive on soils destitute of nitrogenous compounds, where other plants would certainly fail, and for the reason that they are destitute of means for manufacturing the requisite nitrogenous compounds; the elementary form of nitrogen is inert and useless for the purposes of the plant. It is easy to understand how the growth of a crop of clover enriches the land. Root residues are left behind, and these root residues contain nitrogenous compounds, which are readily changed into forms suitable for ordinary plants. These compounds are not obtained from the soil, but are actually manu-

factured from the nitrogen of the air, and so the soil becomes enriched by additions from transformed atmospheric air.

The various species of clover will now be described.

1. Common Red Clover (*Trifolium pratense*), as used in agriculture, is of very few years' duration. The whole plant is slightly hairy, with ascending stems about a foot in height. The stipules are broad and veined, with short subulate points. The leaflets are obovate or oval, often with a horseshoe mark in the centre. The heads of flowers are very compact, nearly globular, and closely resting on a pair of opposite green leaves. The teeth of the calyx are fine and hairy, the lower one the longest, but considerably shorter than the corolla. The latter is red, about ½ in. long, with all the petals united to the middle so as to form a narrow tube. The pod, enclosed in the calyx and the withered corolla, contains but a single seed. Of all the species of clover this is the most nutritious, and the most generally cultivated in all the moister countries of central, northern, and western Europe.

2. Cow Grass or Zigzag Clover (*Trifolium medium*) much resembles the *T. pratense* in botanical characters, but the root is of longer duration and rather more creeping, the stems take a zigzag bend at every leaf, the stipules are narrow and green, with long linear points, the leaflets are usually narrow oblong, two or even three times as long as broad, and not marked in the centre. The flowers, of a bright-red, are larger than in *T. pratense*, and form a less compact head, which is placed on a stalk at some little distance away from the uppermost leaves. The plant is but little cultivated, for, although of longer duration, and better suited to some soils than the common Red Clover, its produce is universally reckoned as much less in quantity, as well as harsher, and not so sweet or nutritive; besides, the seeds are not obtainable in commerce. Seeds of varieties of Red Clover are, however, sold under the name of 'Cow Grass'.

3. Sulphur-coloured Clover (*T. ochroleucum*) has been occasionally recommended for cultivation in warm situations. It has a perennial woody root, and is of rather taller growth than the two last species. It is covered all over with short soft hairs, the stems are erect, the stipules narrow, the leaflets ovate; the heads of flowers are close and compact, as in *T. pratense*, but the flowers themselves are of a pale-yellow or straw colour, with the upper petal or standard remarkably long and narrow. There is also a variety with pink flowers, but, coming from a more southern latitude, it is probably more tender.

4. Crimson Clover (*T. incarnatum*) is an erect, hairy annual, 1 to 2 ft. high; the stipules are broad, with short tips broad and blunt; the leaflets are also broad, and nearly round. The flowers, of a rich crimson, are in cylindrical dense spikes, placed at a considerable distance above the uppermost leaves. The teeth of the calyx are stiff, and not much shorter than the corolla. The cultivation of Crimson Clover as an early green crop, very general in the south of Europe, has of late years very much extended in England, northern France, Belgium, and Germany. There is a late variety, and also a white variety called *T. Molineri*, which, however, is much poorer in produce, without any corresponding advantage.

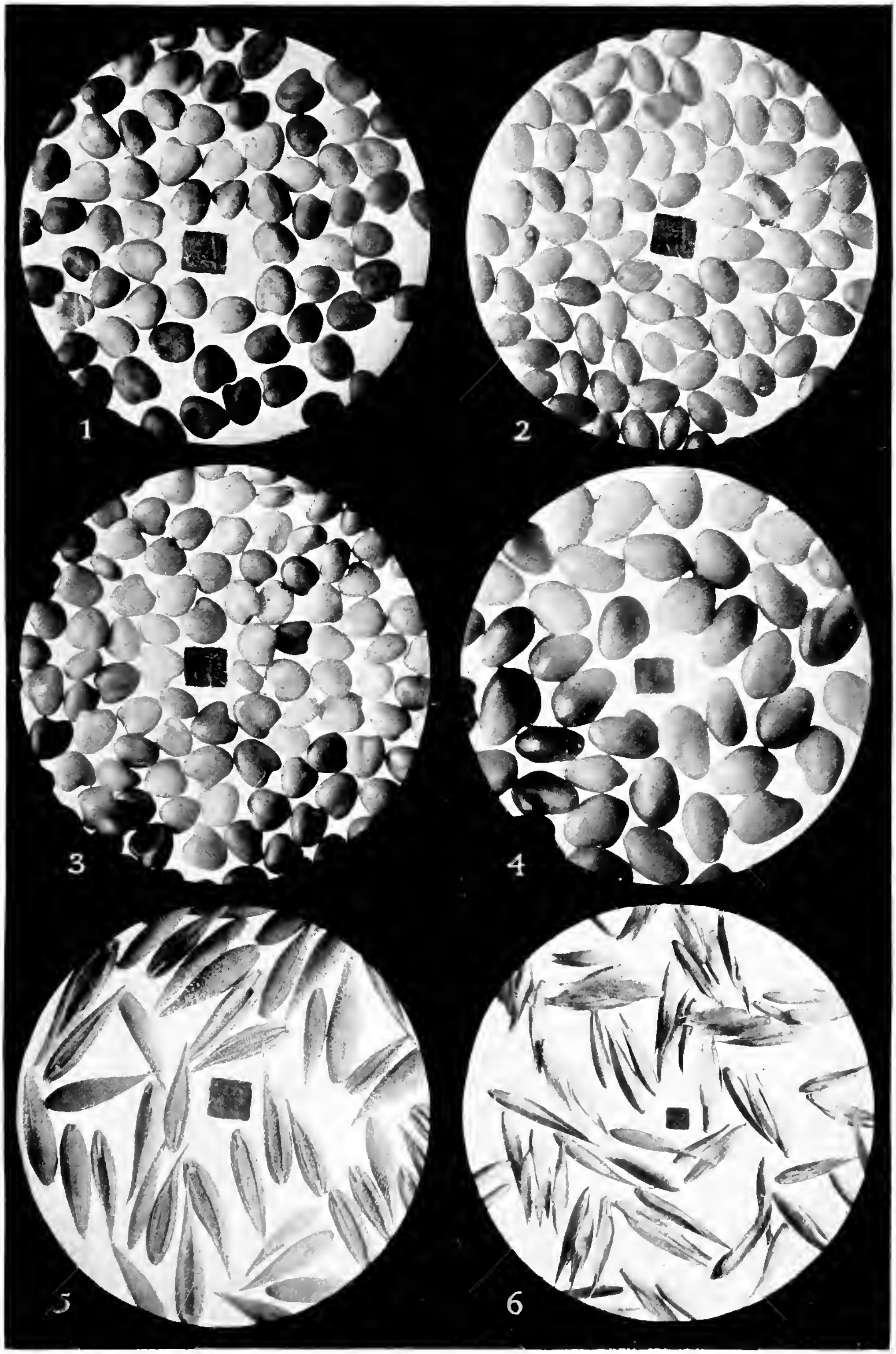
5. Egyptian Clover (*T. Alexandrinum*) is another annual, much cultivated and highly prized for its luxuriant growth in the rich alluvial soils of Egypt, but rather tender for this country. It is nearly smooth, taller and more slender than the *T. incarnatum*, with narrow leaflets and stipules, and small conical heads of pale-yellow flowers. The Italian *T. supinum* is very near to it, but with shorter leaflets and pinkish flowers. The *T. resupinatum*, with small pink flowers, and a calyx much inflated after flowering, with two long points, may also be mentioned as one of the most luxuriant species in some pastures of the south of Europe.

6. White Clover, also known as Dutch Clover (*T. repens*), is a low, smooth perennial, with stems creeping for the most part on the surface of the ground. The stipules are membranous, the leaf-stalk very long, and the leaflets broad, obovate, often with a horseshoe mark in the centre. The flower-stalk bears a globular head, or rather umbel, of numerous white or pale-pink sweet-scented flowers, which, although erect when they first come out, become pendulous as they wither by the curving downwards of their slender pedicels. The calyx is quite smooth, with teeth about as long as the tube. The pod, about the length of the calyx, is enclosed in the faded corolla, and contains three or four very small seeds. This is a most valuable plant for pasturage over the whole of Europe, Central Asia, and North America, and is now introduced also into South America.

7. Running Buffalo Clover (*T. stoloniferum*), a North American species, is very much like our White Clover, but of more luxuriant growth, and more succulent; the flowers are larger, the upper petal, or standard, broader and of a rose-red, the other petals white, and the pod has rarely more than two seeds. Another American Buffalo Clover is *T. reflexum*, resembling Alsike in its mode of growth; but it is hairy, with much larger flowers, and long teeth to the calyx.

8. Alsike Clover (*T. hybridum*) has been long cultivated in the south of Sweden, and is strongly recommended for cold, moist, stiff soils. It resembles the common Red Clover in stature and mode of growth, but is more lasting. The whole plant is bald; the stipules broad and pointed; the leaflets obovate. The flowers, in loose globular heads or umbels, and turned downwards as they fade, are like those of the Dutch (or White) Clover, but rather larger, of a rich rose colour mixed with white. The pods have usually two seeds only.

9. Hop Trefoil (*T. procumbens*) and Suckling Clover or Small Yellow Clover (*T. filiforme* or *minus*) are two species very much confounded by cultivators and seedsmen, and differing, in fact, but little from each other, except in the size and number of their flowers. They have also been much confounded with Trefoil (*Medicago lupulina*), but they are readily known by



Clovers: 1, Alsike; 2, Yellow; 3, White; 4, Red. Grasses: 5, Crested Dog's-tail; 6, Cocksfoot
(The comparative degree of enlargement may be gauged by the size of the small central square = 1 millimetre.)

the generic character of Trifolium, namely, the small straight pod enclosed within the faded corolla. Both are smooth, slender-branched annuals, with decumbent or ascending stems, broad-pointed stipules, and heads of small yellow flowers, which, as they wither, become first whitish, then turn to a pale-brown, with the upper petal or standard marked with longitudinal stripes, and enclosing a small one-seeded pod. Hop Trefoil is the larger plant, and the more generally cultivated, affording excellent forage, though limited in quantity. The flowers are numerous, in dense heads nearly ½ in. in diameter, with the upper petal of each flower broad and strongly striped. Small Yellow Clover (*T. filiforme*) is smaller in every respect; the flowers especially are much smaller, with a narrower and less distinctly striped standard, seldom more than five or six together in small loose heads. Suckling Clover (*T. minus*) is but a slight variety of the latter, rather more luxuriant in growth, with ten or a dozen flowers in the head. But the name is frequently given to the still more luxuriant *T. procumbens*.

[A. N. M'A.]

Clover Sickness and Fungus Diseases.—The diseases of Red, White, and Crimson clovers, Alsike, and other species of Trifolium may be considered together; those of Lucerne, Sainfoin, and their allies will be dealt with separately (see LUCERNE).

CLOVER SICKNESS.—This term is used to describe a widespread disease, the symptoms of which, as given by writers, are not always the same; it appears that the rapid dying off of clover which marks the disease is caused by various agents. It is necessary to distinguish damage done to the clover 'seeds' by oats or barley, from damage done later. After the corn harvest, it is not uncommon to see tracts and patches over which the clover plants are killed; these may be places where the corn has been too dense, or has 'lodged', or where corn sheaves have stood in wet weather; the same thing may occur under a thick undergrowth of weeds, or where water has lodged in hollows. If the clovers die away during the first winter, it may be due to the soil being so acted on by wetting and drying, by frost and thaw, that the clover plants become uprooted, especially if they have not rooted deeply during the first summer after sowing. On the other hand, the disease has been traced to parasitic organisms, and in cases of Red Clover sickness we have almost always found these present. The symptoms are generally observed in the autumn after the corn harvest: the foliage becomes discoloured and covered with a fungus mycelium, the leaf-stalks become rotten and collapse, the young leaves in the crown are next attacked, and a decay or rot penetrates into the taproot. If the decaying roots are examined microscopically, they are seen to be permeated with a fungus mycelium, and are infested with minute eelworms or nematodes (see TYLENCHUS). So intimately do these two parasites work together that it is difficult to say which is the primary cause. The fungus generally present is one of the Ascomycetes (see FUNGI) called *Sclerotinia*; a useful illustrated account will be found in the Journal of the Royal Agricultural Society, vol. lxiv, 1903. The main facts in its life-history are that it forms on living foliage a brownish mycelium without sporules, then minute black sclerotia or resting masses of mycelium are found on the dead plant remains; these sclerotia may germinate at any time, and either produce the mycelium again or give rise to small brownish ascus fruits consisting of a slender stem bearing a flattened disk coated with asci containing ascospores. The sclerotia are produced in large numbers and may survive many years, so that land once infected will probably remain so. This sickness does not easily attack Alsike and White Clover.

Treatment.—After observations extending over several years, we have already recommended the following means of checking sickness of Red Clover (Pamphlet No. 57, Department of Agriculture, University of Leeds, 1906): (*a*) A strong deep-rooted plant of clover; (*b*) grazing by sheep in autumn to reduce thick foliage and to make soil firm; (*c*) a winter dressing of quicklime; (*d*) growing Alsike and White Clover along with Red Clover. During recent years there has been a marked diminution of clover sickness where these measures have been carried out. The crown rot does not kill the root at once, and this treatment aims at retarding the progress of the disease till the following spring, when the roots still alive will put out new shoots. Experiments with spraying fungicides were not successful enough to warrant recommendation. It was also observed that some varieties, such as Chilian, were more resistant than others.

OTHER DISEASES OF CLOVER are less destructive, and are limited to certain seasons or to special districts. Powdery Mildew (*Erysiphe*) causes the leaves to become coated with a white mould, which in autumn becomes studded with tiny black ascus fruits; the growth of the plant may be retarded, but the leaves do not become discoloured. Downy Mildew (*Peronospora*) may become destructive in wet seasons, and the discoloration of the foliage is similar to that in clover sickness. Rust (*Uromyces*) appears in dry seasons as brown spots which give off abundant spores (see FUNGI—'Rusts'). The presence of numerous roundish brown spots (Leaf-spot) frequently accompanies retarded growth; where fungi are present, it is generally *Pseudopeziza trifolii*, but other species have been recorded. In America a disease resembling our clover sickness is known as Anthracnose, and it has been traced to a minute fungus (*Colletotrichum*). The principal damage done by the above fungi is to reduce the crop and to hinder formation of seed. After cutting or grazing off the clover, the land should be ploughed deeply, and if there is reason to suspect deficiency of lime this should be applied before clover is again grown. [W. O. S.]

Clover Weevil. See APION APRICANS.

Club Farms, Club Stocks.—In the north of Scotland, in the hill-grazing districts, a system of farming by which the stock are the common property of the crofters or small farmers of a township is known as club farming. A considerable number of club stocks are to be

found in the island of Skye. The sheep are managed as if they belonged to one man. A shepherd is employed, and all details, such as the selling of cast ewes, lambs, and wool, are undertaken by a small committee. The advantages of a club stock on a common grazing over a number of small flocks held independently are two: overstocking is prevented, as it is for the common good that *all* the sheep should thrive; and continual rounding up or gathering of the whole sheep stock when one man wishes to see his own small flock is prevented. Theoretically, club stocks should be more profitable than a number of small flocks, but owing to the difficulty of getting efficient co-operation at sheep shearing, dipping, lambing, &c., the crofter townships which run club stocks do not seem more prosperous than others.

Here and there club farms may be found where not only the sheep, but the cattle, horses, and implements are common property. The system seems to work fairly well where the holdings are small, and fishing or some other occupation brings in additional revenue. [R. B. G.]

Club - root. See TURNIPS. — PARASITIC FUNGI.

Clump, a term used by gardeners to describe a plant which produces numerous stems from a common rootstock. Some plants if left undisturbed form extensive clumps. For purposes of propagation this habit has its advantages, as the clump may be dug up and divided so as to form a large number of separate plants. [W. W.]

Clun Forest Sheep. — Clun Forest is a hilly district in south-west Shropshire, wedged in between Montgomeryshire on one side and Radnorshire on the other, and forming here a natural boundary between England and Wales. Of old, this extensive tract was all no doubt a 'forest' in the sense of being rough and uncultivated country. Much of it is so still, but the greater part has long been under cultivation, and there is in it some excellent land.

The Clun Forest sheep, sometimes known as 'Cluns', are probably a mixed breed. There is reason to believe that the Clun, the Radnor, and the Kerry hill sheep belonged originally to the same type, and there can be little doubt that they were all more or less closely allied. The original Clun Forest sheep were a small, hardy breed, resembling in some respects a certain type of mountain sheep found at present in mid-Wales. The wool was white, but the colour of the face probably varied, as it does in the modern breed. The Clun Forest flock-owners are said to have crossed their sheep in the first instance with the old Long Mynd breed, an ancestor of the modern Shropshire. In more recent times it is certain that much Shropshire, and possibly also some Ryeland, blood has been introduced. The best Clun sheep now closely resemble the Shropshire breed, whilst others unmistakably suggest their Forest ancestors. The face colour varies considerably, some having tawny or brown, and some speckled faces. Although not reduced to a fixed type, the breed has nevertheless been greatly improved in recent years, and with the greater attention which is now directed to the question of selection it will doubtless continue to improve in quality. As it is, Clun sheep must be regarded as amongst the most useful of British sheep which are suitable for upland districts. The ewes are excellent nurses, and require very little attention during lambing and rearing. There is scarcely another breed of their size and weight which will do so well during winter without artificial food of any kind, and bring their lambs to such perfection, and so early, the following summer. It is rare also to find a composite breed, in which the hill character has been largely retained, that arrive at maturity so early as do the Cluns. At one time Clun ewes were great favourites with lowland farmers on both sides of the Welsh border, for crossing with Down and other tups with a view to the rearing of early lambs. Owing, however, to the introduction of so much Shropshire blood during recent years, it is becoming every year more difficult to obtain Clun Forest ewes of the old type for this purpose, and their place is being taken by Welsh mountain ewes. Clun wethers and ewes when fat may weigh considerably over 20 lb. per quarter, and the mutton is of excellent quality. [C. B. J.]

Clydesdale Horse. — Clydesdale is the ancient name for the county now known as Lanarkshire. A breed of horses bearing the county name must have originated or come to distinction within the area embraced by the name. Any attempt, therefore, to discover the origin in its present form of the Scottish breed of draught horses must, in the very nature of the case, first concern itself with horse breeding in the valley of the Clyde or its tributaries. In the two Statistical Accounts of Scotland, compiled mainly by the parish ministers and published, the first or Old towards the close of the 18th century, the second or New about the middle of the 19th, there is buried much information concerning horses and the trade in horses throughout Lanarkshire and the immediately adjacent counties. Successive writers have made use of that material from time to time, with the result that nothing that is new can be written concerning the early history of the Clydesdale breed. The one broad outstanding fact in all that has been written is that the Clydesdale horse is native to the area after which he has been named, but that there are big differences between the favoured types at successive stages of his modern history. That external influences—from Flanders and from England—have from time to time been grafted on to the parent stem cannot be gainsaid, but amidst all changes a certain ground type has persisted. The modifications effected have been due to the requirements of trade and commerce, and all changes have left some permanent advantage behind them.

The history of the breed may be considered in an orderly way under four epochs: (1) the traditional; (2) the historical; (3) the modern; (4) the systematic. For information concerning the first, which may be regarded as extending from the 12th to the close of the 17th centuries, reference must be made to general history, and inferences drawn from that history. For know-

ledge concerning the second, the progress of Scotland during the 18th and early part of the 19th century provides material. The modern period dates from about 1820 to 1878, and the history of the breed during that period is parallel with the story of the Highland and Agricultural Society, and the development of British pure breeds of every description. Systematic breeding of Clydesdales began with the institution of the Clydesdale Horse Society of the United Kingdom of Great Britain and Ireland in June, 1877, and the publication of the Retrospective Volume of the Clydesdale Stud Book by that society in December, 1878. These past thirty years have witnessed an enormous expansion in the foreign and colonial demand for Clydesdales. This demand has fluctuated from time to time, but taken all in all it has been a great factor in maintaining an interest in the breeding of draught horses in Scotland.

Traditional Period.—Scotland had a good breed of horses from a very early period. There are laws relative to the exportation of horses as early as the days of the Poet King (1424-37). At that time, horses over three years old were permitted to be exported, but during the Regency in 1567 exportation was prohibited. Scotland had often greater intercourse with the Continent in those early days than with her nearest neighbour, England, and there was a considerable volume of trade between France and Flanders on the one hand, and ports on the Scottish eastern seaboard on the other. The old Monkish cartularies contain much information about the trade of those days, but when the best is said for such information, its chief value is antiquarian.

Several of the early Stuart kings were horse fanciers, and did something to improve the native breed, but unfortunately their ideals varied, and anything like systematic improvement was out of the question. One royal patron favoured horses for speed, another wanted war horses capable of carrying men in armour, while possibly a third may have had some ambitions in the direction of a pack horse. The draught horse, as we know it, is obviously a creation of much later date. Not until Scotland had roads could she have had much need of the horse which pulled by the shoulder. Surefooted animals, capable of carrying heavy loads on their backs along bridle paths, would be chiefly in favour, and such a horse would differ in material respects from the active Clydesdale of to-day.

Until the Revolution settlement in 1689 gave the land rest from war there could have been no opportunity for men to pursue the breeder's art, which is distinctly an art of peace. This applies with peculiar force to the native home of the modern Clydesdale. If such a home exists for him anywhere it is in Clydesdale and Avondale, yet these were precisely the districts in Scotland to which the Revolution settlement brought peace. It may therefore be safely concluded that the modern Clydesdale was not in the thought of the men who lived a precarious life on the hillsides and in the moss hags of Scotland. Their horses would be sure of foot and stout of limb, but ability to pull a load was hardly likely to be one of their characteristics.

Historical Period.—Scotland, as a whole, has really no industrial history worthy of the name until the close of the 17th century. When at length the country had rest from turmoil, and the men of Lanarkshire could devote themselves to the arts of peace, they naturally desired to possess horses which would assist them in the tilling of the ground. The opening up of the Lanarkshire coalfields and the rise of manufactures gave a great impetus to agriculture, increasing the demand for its products, and also utilizing its horses. An improved agriculture and an expanding commerce both demand improved horses, and in the cases in point they got them. The Clydesdale breeder of the past is not likely to have fallen short of the Clydesdale breeder of the present in this, that he would endeavour to produce what the market required.

The 18th century and early part of the 19th is everywhere credited with being the birth time of our modern breeds of cattle, horses, sheep, and pigs. The cessation of internecine war, the Union of 1707, the development of trade, and the making of roads, all called for a horse that could pull as well as a horse that could carry, and the horse wanted was produced by the farmers of Clydesdale. The foundation was already at hand; the question is, What was built upon that foundation? Sundry traditions all point to the Flemish stallion being the agency employed, although those who look at the Flemish stallion of to-day may be forgiven a measure of scepticism as to that. The importation of Flemish stallions is variously credited to one of the earlier Dukes of Hamilton, to one John Paterson of Lochlyoch, in Carmichael parish, in the Upper Ward, and to James, sixth Duke of Hamilton (1742-58), who kept a dark-brown Flemish stallion for the use of his Lanarkshire tenantry at Strathaven Castle. It is not necessary to attempt to reconcile the various theories, which do not really conflict. There is no reason why John Paterson should not have had a Flemish stallion at Lochlyoch about 1715-20, and James, sixth Duke of Hamilton, another in Avondale from 1742-58, or for that matter another Duke of Hamilton 'six fine black stallions from Flanders' at Strathaven Castle a century earlier. The likelihood is that all three stories have a substratum of truth, that the 'nag' which served the upland farmer in the day of bridle paths and warlike forays was improved and enlarged by the use of sires of an alien breed, stronger and larger than that with which they were mated. The Lochlyoch mares were rather famous during the closing quarter of the 18th and first quarter of the 19th centuries, and there is a well-authenticated story of one of them having been the ancestor of one well-known strain or family among modern Clydesdales. An English stallion named Blaze was brought upon the scene by another of the Patersons of Lochlyoch about the year 1780, and as late as 1836, in a published account of a 'love darg' at Drumalbin to

the first Paterson of Lochlyoch, who removed thither, this horse is spoken of as 'having founded the famous Clydesdale breed of horses'. This is a somewhat liberal tribute to the success of one horse, but doubtless careful selection and better treatment of the stock descended from him and the native Lanarkshire mares would effect wonders.

The improvement of agriculture would do much to mould the type of draught horse wanted, and a writer about the year 1812 lays emphasis on this aspect of the question. He refers to the fact that the Lothians and Berwickshire depended for their horse supplies on the western counties of Scotland and the northern counties of England. In vol. ix of the Old Statistical Account (Rutherglen parish) we are told that the farmers up the country had taken advantage of the introduction of the Flemish stallions, that numbers of colts were sold at Lanark and Carnwath and were then trained for draught, and were sold at the Rutherglen fairs, and 'taken to the Lothians, England, &c.' At this period it was understood that the breeding area for horses would follow the development of pastoral farming and turnip growing; and this is precisely what has happened. The districts in which intensive agriculture is prosecuted have rarely been successful in breeding horses. The best have generally been bred where dairying and turnip growing are prosecuted. Consequently horse breeding gradually extended to Galloway, where the Clydesdale may be said to have found a second home. The early history of horse breeding in Galloway is shrouded in mystery. Like Clydesdale and Avondale, the Stewartry and Wigtownshire had little rest during the Covenanting period. Many of the most stirring incidents of that time were associated with the south-west of Scotland, and farmers there during the latter half of the 17th century would have little leisure to prosecute horse breeding. But there was an earlier experience in that part of the country. The moss-troopers who maintained a precarious existence on either side of the border did a good deal in the way of horse stealing. They found animals swift of foot and stout of limb on the farms, and they were disposed to take possession of these as it suited them.

The point of much that has been written in these old accounts is that the development of the modern Clydesdale in his native district and in Galloway is not due to the influence of any one horse, but to the union of the blood of several horses of outstanding draught type with the heavy, thick, short-legged, active, native breeds found in these areas. Blaze undoubtedly left his mark in the Upper Ward of Lanarkshire, but he could have left no mark had there not been a breed there of such stock as a mark could be left upon. The distinctive characteristics of the modern Clydesdale can be clearly traced in what account is given of these early horses. Alike in Clydesdale and in Galloway we see a horse short in the leg, stout and clean in the limb, with sound feet and a well-rounded barrel. That, in brief, is the Clydesdale of to-day as aimed at by breeders, and these are characteristics not imposed on the breed by Blaze or any other horse. They are the foundation of all subsequent improvement.

Modern History.—Clydesdales have not up to this date been classed as such at the shows of the Highland and Agricultural Society. For more than a century the breed has simply been officially described as agricultural horses. This, however, does not alter the fact that nearly all the horses shown at the national events have, during a period of at least 120 years, been native born. The outstanding exceptions to this rule are found during the years 1870–84, when the late Lawrence Drew, tenant of the farm of Merryton, Hamilton, and some others successfully exhibited mares bred in England. From time to time the names of horses occur in the lists which were also bred in England, but taken as a whole, the history of the development of the Clydesdale breed during sixty years is recorded best in the annals of the Highland and Agricultural Society. The earlier catalogues, however, give very little information regarding breeding. The only clue to pedigree is the place of foaling, and the district in which a horse may have been travelling.

There were local shows at a very early period in Scotland, and authentic records of Clydesdales exhibited at these are sometimes of earlier date than the records of horses in the national annals. This is true in a special degree of Galloway, where shows seem to have been held long before the time of Anderson of Drumore, the acknowledged leader in the advance movement in the Rhins. The natural course of procedure, however, is to follow up the trail from its beginnings in the Upper Ward, and so endeavour to reach the goal of the present day.

It is ascertained historical fact that the Lochlyoch mares were of high repute very early in the 19th century. The tradition is that a mare locally and now historically famed as 'the Lampits mare' was purchased at a displenishing sale at Shotts Hill Mill in 1808, and was descended direct from the Lochlyoch stock, if she was not actually bred at Lochlyoch by a descendant of that John Paterson who brought a black stallion from England about the year 1715. The tenants of Shotts Hill Mill were Clarksons, related to the Patersons of Lochlyoch. These Patersons removed to Drumalbin, in Thankerton parish, in 1836, as has been said, and their descendants are with us until this day, eminent not only in agriculture, but also in divinity. 'The Lampits mare' bought at Shotts Hill Mill in 1808 is in the Introductory History to the Retrospective Volume of the Clydesdale Stud Book credited with being the dam of Thompson's black horse Glancer (335), but the writer is more than sceptical as to the truth of this. He has elsewhere given his reasons, and it is sufficient to say here that too much has possibly been made of the supposed linking of almost the whole modern Clydesdale race with 'the Lampits mare' through Thompson's black horse Glancer (335). The test of dates was not too rigorously applied by those who searched out the material embodied in the Introductory History referred to.

Germiston, the farm tenanted by James Thompson, who owned the black horse Glancer (335), lay in the vicinity of Tollcross, to the east of Glasgow. A travelling card of the horse (undated) is printed in the Retrospective Volume of the Clydesdale Stud Book. From it we learn that his fees were 'one guinea and a shilling to the groom'. It is undoubted that the most influential tribes in the Clydesdale race are descended from this horse. The line of descent is through Broomfield Champion (95), a horse owned by Mr. James Frame, Broomfield, Dalserf, in the valley of the Clyde above Hamilton, and bred in the parish of Shotts. This great horse left a lasting impression on the breed in Clydesdale, and he has also been identified with a horse known as Aberdeen Champion in the north of Scotland. His most noteworthy descendant was Clyde *alias* Glancer (153), known as 'Fulton's Ruptured Horse', a strong masculine animal, probably rather coarse if judged by the standard of the present day, but a most impressive sire. His best-known sons were Clyde *alias* Prince of Wales (155), a Highland and Agricultural Society first-prize winner; Farmer *alias* Sproulston (290), which made history in Bute and Wigtownshire; Erskine's Farmer's Fancy (298), which secured high honours at the national shows, and left a strong impression on the Clydesdales of Kintyre; Muircock (550), a great horse of strong individuality which travelled in Renfrewshire and north Ayrshire; Prince Charlie (625), a grey horse which travelled for many a day in the lower district or Machars of Wigtownshire; Barr's Prince Royal (647), a phenomenally successful show horse, and sire of show winners in Renfrewshire; and Baasay (21), not a show horse, but evidently a horse of great individuality which bred useful stock in Renfrewshire. These seven stallions made the Clydesdale breed in the West of Scotland. Their influence was all-pervading there, and even beyond, although other sires share the honours with them in the south, west, and north.

The modern era in Clydesdale breeding in Galloway is connected with the names of several gentlemen more or less closely identified with Lanarkshire. The family of the Muirs went from Sornfallo, on the slopes of Tinto, to the Stewartry in 1840, and took with them horses and mares of the true Clydesdale stamp. These were mated with the native stocks referred to in an earlier part of this article, and the combination gave the world the Clydesdale of the closing half of the 19th century. But Lanarkshire horses had been imported into Galloway before the Muirs came to Kirkcudbright. The system of hiring seems to have begun very early in that part of the country. Samson (1288), a Lanarkshire horse, foaled 1827 or 1828, and his grandsire, a horse named Smiler, which must have been foaled very early in the century, both travelled in the district. John Muir came from Sornfallo to the Banks about 1840; his brother James had a few years earlier come from Sornfallo to Maidland, Wigtown. Both brought Clydesdales in their train, and to this fact may be traced the breeding of one of the epoch-making horses, Lochfergus Champion (449). The Rhins of Galloway was the scene of the early rivalry of Colonel M'Douall of Logan, and Mr. Robert Anderson, Drumore, for the Clydesdale supremacy. In 1835 the latter introduced Old Farmer (576), and a black mare, Old Tibbie, and her neighbour from Lanarkshire and Renfrewshire. But the Lanarkshire foundation had been drawn upon at an even earlier date. Agnew's Farmer (292), from Balscalloch, Stranraer, won a £30 premium at the Highland and Agricultural Society's show at Dumfries in 1830, and his sire was a horse named Clydeside, which could hardly have borne that name unless he had come from the valley of the Clyde.

The Clydesdale has long been successfully bred in the peninsula of Kintyre in Argyllshire. The tribes there are clearly descended from the Lanarkshire centre, and the subsequent history of the race is linked with that of the mainland, and in particular of the Rhins of Galloway, through Rob Roy (714), a very notable horse, which travelled both in Kintyre and Wigtownshire. The first improvement from the native Highland garron is credited to a black horse or black horses brought into the peninsula by the laird of Lee in Lanarkshire, who then also owned land in Kintyre. Its subsequent development during the years under review is closely associated with the horses Farmer's Fancy (298), of the main trunk line from Broomfield Champion (95); Rob Roy (714), whose 'pedigree' in the usual acceptance of that term is doubtful, his sire being an unnamed two-year-old colt, and his dam a three-year-old filly, which mated themselves 'without consent of clergy'; Largs Jock (444), which belongs to the same Ayrshire race as the celebrated Sir Walter Scott (797), the champion at the Royal International Show at Battersea in 1862; and Lorne (499), a horse which lived long and left many foals. All of these four horses were owned locally, and did splendid service, but all of them had grave defects. The first, Farmer's Fancy (298), gave Kintyre a heritage of 'boxy' fore feet, which it has been hard to eliminate; Rob Roy (714) had a long hollow back, and impressed that on his progeny; Largs Jock (444) had the characteristic defect of his tribe, 'straight hocks'; and Lorne (499), while imparting great substance and weight to his produce, left many of them with short and upright pasterns. Along with these defects each horse had many outstanding excellencies, and perhaps on account of its almost insular position, Kintyre furnishes as useful a school for studying problems in horse breeding as any district in Scotland.

The north of Scotland and the north of England are both within the native Clydesdale breeding area, yet they are so with a difference. The connection between these districts and the home of the Clydesdale can easily be traced, but the original elements were not the same as in the districts north of the Tweed and Solway, to which reference has been made. Shire horses undoubtedly travelled in both localities, and left their mark on the character of the produce. And in Aberdeenshire there is evidence that the laird of Pitfour imported what he called Suffolk stal-

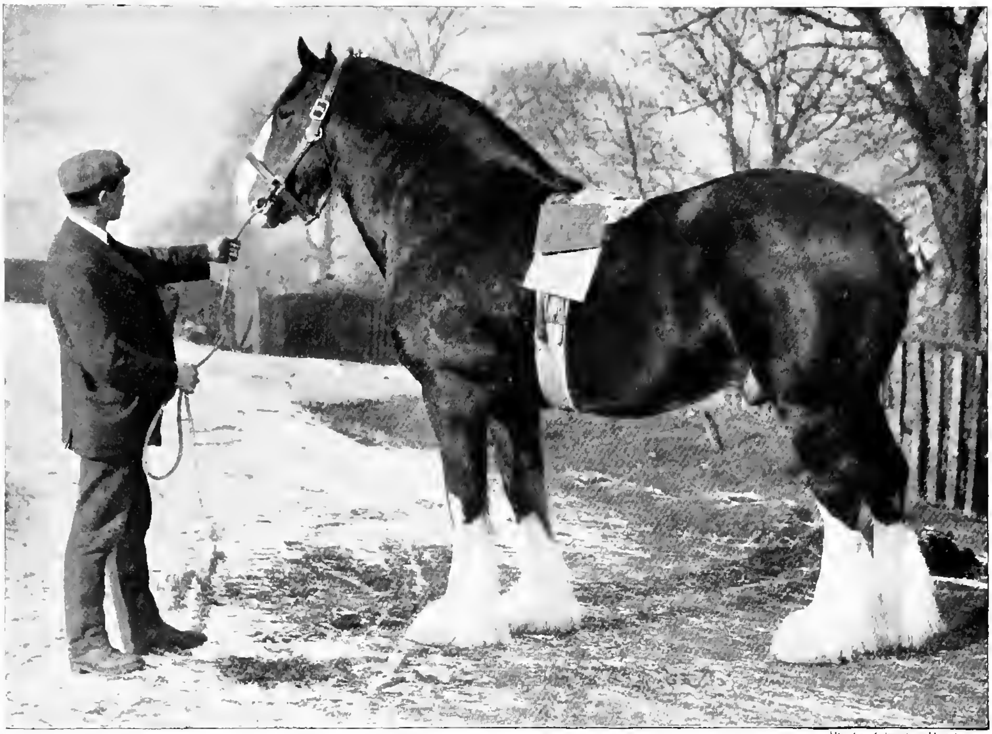
lions, although from the descriptions of these horses it may fairly be doubted whether they were of the race of the famous sorrels or chestnuts so long bred in East Anglia. It is more than probable that the Pitfour stallions came from East Anglia, but the roughness of their legs suggests the Fen country as their home, and the old English Cart Horse as their ancestor. There were, however, Suffolk stallions in Buchan, and one of them was quite well remembered by farmers twenty-five years ago. Cumberland and Westmorland, although aiming at Clydesdales, must acknowledge indebtedness to Shires. As cart horses no class of Clydesdales are more valuable than those bred in these districts.

The main connecting link between Lanarkshire and Cumberland is Pringle's Young Clyde (949), bred in 1826 near Hyndford Bridge, Lanarkshire. He was a big horse with remarkably good feet and legs, but a little short in rib. He spent a long life in Cumberland. The other lines of breeding there are all more or less closely identified with the Clydesdale centres. Blyth (79), a horse with coaching blood in his veins, was bred in West Lothian, and related on the sire's side to Broomfield Champion (95). He founded a grey line, which colour has been strikingly displayed in Cumberland families of the highest reputation. His son, Young Blyth (923), was also grey, and travelled both in Cumberland and Aberdeenshire. The grey Glenelgs (357) were descended from Young Clyde (949), and had a similar record. Both Blyths and Glenelg were prizewinners at the Highland and Agricultural Society shows in the 'forties and 'fifties. The most famous of all the Cumberland greys was Merry Tom (532), which won first at Glasgow in 1852 when four years old. His breeding analyses in much the same fashion as the pedigrees already referred to. The main lines are of Lanarkshire descent, but the foundation was a mixed race of heavy cart horses with a dash of the blood of the Coach Horse. Two notable Shire horses in Cumberland were Farmer's Glory, owned by John Robinson, Wallace Field (known for two seasons in Ayrshire as Andrew Hendrie's Farmer's Glory), and Nichol's Topsman.

The history of the introduction of the Lanarkshire horse into Aberdeenshire begins with Young Glancer, which in 1823 came to the county. He is believed to have been a son of Glancer (335), Thompson's black horse. He was not a high horse, his height being given as rather under 16 hands. He was first at Hamilton when three years old. Young Champion of Clyde, foaled in 1840, was at Mill of Ardlethen, Udny, for several years. He came from the west of Scotland. Mr. Barclay of Ury introduced Clydesdales, as he introduced Teeswater cattle, and had good success with both. A little later came the famous Comet race; the best of which was the grey Comet (192), a winner at the Highland and Agricultural Society show in 1856, and Lord Haddo (486), a very notable horse, of the same line of breeding on the sire's side as Largs Jock (444) and Sir Walter Scott (797). These gave a certain stamp of Clydesdale character to the northern draught horse, and about thirty years afterwards this work was renewed with vigour, so that at the time of writing it may safely be said no district in the country produces a larger proportion of genuine Clydesdales of the highest class than Aberdeenshire, Morayshire, and the counties between and adjacent.

The broad effect of the foregoing outline is undoubtedly to show that the Clydesdale is largely a composite breed. There has been close adherence to one type and one family of horses. Lanarkshire or Clydesdale provided the home of these animals, which, however, came to be more successfully bred away from the parent headquarters. In various localities, from time to time, horses which would now be called Shires were in use, and undoubtedly contributed something to modification of type, but that may have been less than might have been expected. And for this reason. It is matter of history that during the latter part of the 18th and the opening quarter of the 19th centuries a large number of young Clydesdales were purchased at Rutherglen, Lanark, and Biggar fairs, and taken in droves to England. These young colts and fillies were driven south in 'mobs', and distributed over the midland counties by dealers who made this their business. No doubt this explains why Shire horses were brought north possessing many of the best characteristics of the Clydesdale. The late Alexander Galbraith, Croy-Cunningham, Killearn, owned several such horses, and notably one named Tintock, which won second prize at the Highland and Agricultural Society show at Glasgow in 1867. This horse, like Hendrie's Farmer's Glory, left a large number of very superior fillies which developed into highly successful brood mares. These were spasmodic efforts, but about the year 1870, and until 1884, when he died, the late Lawrence Drew, who was tenant of the farm of Merryton, near Hamilton, made systematic efforts to blend the northern and the southern breeds. He stoutly resisted the proposal to have two stud books, maintaining to the last that Clydesdales and Shires were not two distinct breeds, but, like Booth's and Bates's Shorthorns, two distinct strains or tribes of one breed. He owned the Clydesdale stallion Prince of Wales (673) (foaled 1866, died 1888), one of the grandest draught stallions ever foaled, and purchased mares in England expressly selected for the purpose of mating them with that horse. From the combination Mr. Drew bred a remarkable succession of first-class animals, which won the highest honours. But in spite of the admitted merits of the produce, Mr. Drew failed to convince his countrymen that he was right, and when he died in March, 1884, it may be said that the effective opposition to the Clydesdale Stud Book movement also expired.

The Period of Systematic Breeding.—When the Clydesdale Horse Society of the United Kingdom of Great Britain and Ireland was founded on the model of the Shorthorn Society, in June, 1877, the promoters had to take the breed as they found it. The foregoing historical sketch shows clearly enough that the breed was



Photo, Charles Reid.

CLYDESDALE STALLION—"HIAWATHA"

THRICE WINNER OF THE CAWDOR CHALLENGE CUP AT THE SCOTTISH STALLION SHOW, 1898, 1899, and 1901.

Photo Charles Reid.

CLYDESDALE MARE—"MOSS ROSE"

WINNER OF 13 CHAMPIONSHIP CUPS AND INNUMERABLE FIRST PRIZES
(PHOTOGRAPH TAKEN WHEN 13 YEARS OLD)

composite, and the initial difficulty which presented itself to the Council of the Society was how to preserve the purity of a breed which had to a certain extent already been 'contaminated'. They adopted the plan of settling on a historical basis the foundation of pedigree, and of recognizing as Clydesdales all living animals popularly classed as such, which could show at least on one side an unbroken descent from the Lanarkshire fountain-head according to the facts as collected from documentary evidence and the traditions of the older men connected with the horse-breeding industry in Scotland. Unfortunately the Council had to contend with the active opposition of Mr. Lawrence Drew and a small but influential body of supporters. Several of these had access to facts which would have been of material assistance to the Council, and several excellent mares, in particular, had to be regarded as of unknown breeding, which in all probability had a Clydesdale history if it had been revealed. The principle of one proved cross of Clydesdale blood (as above defined) was applied to all living stallions foaled before 1875, and to all living mares foaled before 1877. To have a recognized Clydesdale sire and a dam got by a recognized Clydesdale sire was made the standard of admission for animals foaled after these dates and up to 1880. In the year 1898 the regulations were consolidated, and the standard fixed as from 1st January, 1890. All animals foaled before that date, not previously registered, were accepted for entry if conforming to the rule of sire and sire of dam being registered; all foaled in and after 1890 were, and are up to the time of writing, accepted if got by a registered sire out of a registered dam, or out of a dam whose sire and sire of dam are registered. In dealing with animals foaled before 1890 in whose pedigree ran the blood of any of Mr. Drew's horses, or horses similarly bred, admission was granted to the Stud Book if the required proportions of recognized Clydesdale breeding were found in the pedigree. These proportions are seven-eighths recognized Clydesdale breeding according to the standard of such breeding set up in dealing with historical horses. It seems needful thus to explain the position of the breed society, whose policy has undoubtedly moulded the type during the past thirty years.

The chief credit of founding the Clydesdale Horse Society and the Clydesdale Stud Book belongs to two gentlemen—the late Earl of Dunmore, who died in September, 1907, and Mr. John M. Martin, in 1877 farming Auchendennan, Alexandria, and Hawthornhill, Cardross, in Dumbartonshire. The labours of these gentlemen and their associates were splendidly seconded and their policy carried out by Mr. Thomas Dykes, the first secretary of the Society (1877–1880). For several years prior to the foundation of the Stud Book, Mr. Dykes acted as agricultural correspondent of the Glasgow News. He was the pioneer in descriptive reporting of horse shows, and being deeply interested in Clydesdales, his writings did much to pave the way for the success of the Society and Stud Book when they appeared.

Scarcely less influential than the Clydesdale Stud Book has been the work of the Glasgow Agricultural Society, which for more than half a century has organized and carried on a spring show of Clydesdale stallions in the western city. Shows of a like nature were formerly held all over the country, at which stallions competed for premiums offered locally to encourage owners to place their horses in these districts. The expense of holding numerous small stallion shows was very great, and about the year 1870 or thereby all of the local events were given up, and one great show and hiring fair held in the Glasgow Cattle Market. This event usually took place in February, and up to 1882 no district horse-breeding society thought of hiring a horse until the stallion show. The Glasgow Society undertook all the risk of organizing the event, and contributed two £100 premiums for two horses, the stipulation being that these should travel in the Glasgow district. Any contract previously made with another society was nullified should the selected horse be chosen for Glasgow. The deputations representing the local societies received tickets of admission to the show, and a separate enclosure was set apart for them in the judging area, whence they had a good view of the horses shown in both rings. In 1882 this arrangement sustained a severe shock when an Aberdeenshire society who had engaged Lord Erskine (1744), then an unknown three-year-old horse, beforehand, had to surrender him to the Glasgow Society. In the autumn of that year the same society engaged him for 1883, and from that date onwards the system of hiring privately has become increasingly prevalent. For several years past, a greater number of horses have been hired for the ensuing season at the Highland and Agricultural Society's show in July than at the spring stallion show. As a hiring fair it has almost ceased to have any importance, but as an exhibition of Clydesdale entire horses it is unrivalled.

Horse-hiring societies are indigenous to Scotland. They date from a very early period. There was one in the western Midlothian or Mid-Calder district as early as 1837; the Strathearn Society has records of hiring from 1855; the Royal Northern Society (Aberdeen) began to hire in 1853, and still holds a spring show of its own for the purpose. The Bute and Clackmannan societies have complete records from 1871, and indeed it may be said generally that renewed vigour began to be shown by most local societies about that date. Kinross has records from 1860, and the Dalbeattie district of Kirkcudbright from 1861. West Lothian can claim an unbroken selection from 1869, and Selkirk and Galashiels from 1868. The existing records of the two Wigtownshire societies date from 1870. The number of such societies has increased greatly during the past twenty years, and usually about a hundred horses are now under hire throughout Scotland in each season. The terms on which such horses are engaged differ widely. In some cases a guarantee is given by the society of a season of eighty mares at fixed terms, say £3 at service and an equal

sum when the mare proves in foal. This should yield, with a fairly prolific sire, an annual revenue of about £360. The allocation of the money may and does vary, but it may be taken that this represents the income of a horse of more than average merit. Some are hired for a premium of £50, with 30*s.* service money, and £2 additional if the mare proves in foal. No guarantee of mares will be given, but should the horse prove fairly popular, and each member of the hiring committee prove loyal to him, in most districts he would get eighty mares. This would bring out an annual revenue of about £250. Of course much higher terms are paid for the champion horses. Those that are untried as sires although distinguished in the show ring can be hired to draw an income of £500, and in the palmy days of 1884, 1885, and 1886, Darnley (222) was hired to the Rhins of Galloway to net a season worth £1000. He is a very disappointing horse which cannot under the Scots hiring system draw at least £200 in one season.

Successful Sires.—The horses of outstanding merit as sires from 1878 to 1885 were possibly Drumflower Farmer (286) and Lord Lyon (489). Darnley (222) was slowly but surely coming to his own, but a considerable change had to come over the popular view of the highest merit in a Clydesdale before the Darnley type assumed supremacy. From 1886 to 1892 the leading Clydesdale sires were either of the two races named or of the Darnley (222), Drew's Prince of Wales (673), Lord Erskine (1744), or Old Times (579) tribes. Prince of Wales (673) was foaled in 1866, and after a very distinguished show career, his reputation as a sire began to assert itself about the year 1871. Very grand mares and fillies after him were exhibited, including Knox's black mare Rosie, dam of Dunmore Prince Charlie (634), which was wellnigh invincible, and several daughters of the fine old show mare London Maggie (84). Colts out of selected Shire mares, and bred by Mr Drew at Merryton, were frequently in the first place at the leading shows. These were characterized by great substance, and always carried plenty feather. An outstanding characteristic in all, however, was action. The old horse himself was a specially gay mover, and his stock, as a rule, inherited this property. So successful had Prince of Wales (673) become, that for several years up to 1884 his terms to the public were £40 at service. At the Merryton dispersion sale on 17th April, 1884, he passed into the hands of Mr. David Riddell at 900 gs., being then eighteen years old. He lived until the close of 1888, when he died after two most successful seasons' work in the Rhins of Galloway. Much dispute has been waged regarding the breeding of this very remarkable horse. His sire was General (322), and his dam Darling, by Samson *alias* Logan's Twin (741). Both sire and dam were first-prize winners at the Highland and Agricultural Society's show at Inverness in 1865, where they were mated, and the produce was Prince of Wales (673) in 1866. The dams of both General and Darling were grey mares, and came from south of the border. The opinion of the writer of this article, based on evidence which he has elsewhere detailed, is that the sire of the dam of General (322) was Merry Tom (532), and the sire of the dam of Darling may have been Blyth (79). Others say they were English, that is Shire mares. They certainly were English in respect that they came from south of the Solway to Dumfries market, where they were bought by a West of Scotland dealer. That they were Shires there is no proof.

Darnley (222) up to his death was the most successful breeding stallion known in Clydesdale history. He was a less showy horse than Prince of Wales (673), and there is no doubt as to the Clydesdale or old Lanarkshire origin of all the lines in his pedigree but one. His sire Conqueror (199) was a son of Lochfergus Champion (449), and his dam was Keir Peggy (187), a daughter of Samson (741), while her dam was a daughter of Farmer's Fancy (298). The one unknown strain in Darnley's ancestry is the grand dam of Samson (741). She was a chestnut mare, bought in Falkirk tryst by Mr. Jack, Balcunnock, Campsie, and nothing is known of her breeding. Darnley was bred at Keir, Dunblane, by Sir William Stirling Maxwell, Bart., and from 1875, when he was three years old, until the autumn of 1886, when he died, he was owned by Mr. David Riddell. He won the highest honours both of the Highland and Agricultural Society in 1877, 1878, and 1884, and the Glasgow stallion show in 1876 and 1877. He was a horse of great character, brown or dark dappled bay in colour, with a white mark on forehead and one white hind leg. He had a first-rate well-shapen foot, of the best material, pasterns set at the right angle, good hard bones and clean limbs, a splendid neck and well-laid oblique shoulders, with high withers, and good barrel. His head was inclined to the pony shape, and his quarters were short and drooping. He was a splendid walker, moving with a long, swinging, cart-horse stride; but his trotting action was defective, especially in front. In respect of trotting action he was distinctly inferior to Prince of Wales (673), but as a sire of breeding stallions and mares he was in his time without a peer. His reputation may be said to have endured for a decade after his own death. His stock came slowly to maturity, as he did himself; but in type, character, substance, and in the main soundness, they were first, and the second was some distance behind. From about 1880 to 1890 the produce of Darnley and his sons, Macgregor (1487), Top Gallant (1850), Sanquhar (2393), Flashwood (3604), and others, dominated the show yards and fixed the fashionable Clydesdale type. Prince of Wales followed Darnley in the Rhins of Galloway in 1887 and 1888, and among the large crops of foals left by him in these two seasons out of young mares got by Darnley were some of the choicest specimens of the breed ever exhibited. They sold as foals for unprecedented prices—one, Prince Alexander (8899), making as high as £1200 before one year old, while £500 was a common enough price for both colts and fillies got in the way indicated.

In spite of their fine quality and beautiful action and symmetry, there can be no doubt that animals of the Prince of Wales–Darnley cross were frequently lacking in cart-horse character. The reputation of the breed in this particular was saved largely by a new combination of the same strains of blood in a later generation.

Sir Everard (5353) was undoubtedly the sire which saved the situation. He was got by Top Gallant (1850), a son of Darnley (222), and himself a Glasgow champion horse in 1880, out of a mare by London Prince (472), a son of Prince of Wales (673) and the renowned champion mare London Maggie (84). Sir Everard's pedigree traces back for several generations on the female side to the old Lanarkshire fountain-head. He was a masculine horse of weight and substance. He was bred by Mrs. Lamont, Killellan, Toward. Foaled in 1885, in March, 1891, he stood fully 17·1 hands high, girthed when in ordidary condition 8 ft., and weighed 20¾ cwt., or 2324 lb. He measured 26 in. round the upper muscles of the forearm, 17 in. round the knee, had 11 in. bone below the knee, and 12 in. bone below the hock. He was a horse of great depth of rib, with a short back and splendid quarters and thighs. The formation of his hind leg was faultless, and in front he stood well up at the shoulders, his withers being high and well furnished with muscle. His neck was perhaps rather short, and his fore feet might have been stronger. Taken all in all he was a most massive and weighty cart horse. Sir Everard was owned by Mr. Wm. Taylor, Park Mains, Renfrew, and in 1888, 1889, and 1890 was awarded the Glasgow premium. Mated with daughters of Prince of Wales (673), he proved a most successful sire, and two of his sons, The Summit (9442) and Sir Morell Mackenzie (9614), like himself, were awarded the Glasgow premium. It was, however, when mated with a mare of Darnley descent that Sir Everard achieved his highest distinction, and in his son Baron's Pride (9122) is found the most successful breeding stallion the Clydesdale breed has produced.

Baron's Pride was bred by Messrs. Findlay, Springhill, Baillieston, in 1890, and in 1893 was purchased by Messrs. A. & W. Montgomery, Kirkcudbright. In 1894 he was champion male Clydesdale at the Highland and Agricultural Society show at Aberdeen, and since 1896 he has dominated the Clydesdale world. His stock have led in the show ring almost regularly since that date, and in 1908 he again headed the list of winning sires, while among the first twenty of these sires many of his sons find a place. It is difficult to describe Baron's Pride, just because he is a horse of such evenly well-balanced merit. Having since 1894 been kept in hard breeding condition, his measurements would not afford a fair comparison with those of horses fed and kept for show ring. However, it may be said that he stands fully 17 hands high, and is very proportionately built. The quality of his bone, its breadth and thinness, with cleanness and hardness, are the thing wanted by Clydesdale breeders, while his feet and pasterns are respectively of the formation and 'set' required. When taken to Kirkcudbright in 1894 he was mated with mares got by Macgregor (1487), and the combination proved successful to a degree. He also mates very successfully with animals of Prince of Wales descent, the most outstanding representative of which tribe at the time of writing being Hiawatha (10,067).

Hiawatha is the most successful show stallion on record. He is a tall handsome horse, with great flat clean bones, and the best of feet and pasterns. He has won a greater number of champion honours than any other Clydesdale sire, and in the season of 1907, as in several that preceded, he stood next to Baron's Pride in the list of winning sires. Possibly the best animals got by him are those out of mares by Baron's Pride. He was bred by Mr. Wm. Hunter, Garthland Mains, Stranraer, in 1892, and is owned by Mr. John Pollock, Paper Mill, Langside. His sire, Prince Robert (7135), was first at the Royal Jubilee Show at Windsor in 1889, and as an aged stallion at the Glasgow stallion show in 1892. His dam, Old Darling of Garthland (7365), was got by Auchleach Tom (877), and his grand dam was by Lord Lyon (489), from an old Galloway foundation. His dam was an exceptionally good Clydesdale mare, up to a big size, with first-rate feet and legs, and a frequent first-prize winner at the Stranraer Show. Hiawatha himself, when rising nine years old, was 17·1 hands high, and weighed 19 cwt., or 2128 lb.

Sales and Exportation.—The value of the Clydesdale is best illustrated by actual figures based on sales by public auction held during the past thirty years, and the reported figures of exports of pedigree horses and mares since the systematic registration of these figures began. The following list of auction sales is not complete, but the figures given are authentic:—

Date.	Place.	Nos.	Averages. £	s.	d.
20th October, 1876	Knockdon	22	209	15	2
April, 1878	Merryton	50	168	11	0
8th April, 1879	Merryton (partly Shires and 'Crosses')	55	112	11	0
August, 1879	Auchendennan	13	114	5	9
April, 1892	Montrave (a draft) (highest, Queen of the Roses, two-year-old filly, 1000 guineas)	29	149	15	0
21st February, 1895	Eastfield (stallions only)	38	168	8	10
16th April, 1896	Edengrove (Carlisle)	16	116	19	8
March, 1900	Balmedie (dispersion)	18	110	6	2
23rd May, 1901	Mains of Airies (dispersion)	19	141	7	9
30th October, 1903	Drumflower (dispersion)	9	134	12	8
9th March, 1905	Blacon Point (draft at Lanark)	30	152	3	7
11th October, 1906	Blacon Point (dispersion)	14	216	10	6
17th September, 1907	Harviestoun (draft at Perth)	15	149	17	5

There has been a more or less constant demand for Clydesdales from foreign countries for nearly three-quarters of a century. Australia and New Zealand used to be looked upon as sure customers for anything of an exceptionally high order, and during the thirty years from 1850–80 many of the best horses and mares bred in Scotland went to these southern colonies. In 1880 a demand of quite a different character sprang up in the United States and Canada, and continued for about ten years. Quantity rather than quality was the characteristic of this demand. During the last decade of the 19th century it fell away, but the opening years of the 20th century have seen a great revival in the demand from Canada. The following figures taken from the records of the Clydesdale Horse Society tell their own story.

Number of Clydesdales exported in Year	Certificates issued.	Number of Clydesdales exported in Year	Certificates issued.
1884	500	1896	56
1885	514	1897	57
1886	600	1898	132
1887	920	1899	250
1888	1149	1900	178
1889	1040	1901	167
1890	554	1902	266
1891	349	1903	411
1892	158	1904	536
1893	110	1905	653
1894	21	1906	1317
1895	15	1907	1100

Markets at Home.—The Clydesdale is in good repute for city traffic. Excelling as he does in wearing qualities of feet and limbs, contractors have long held him in favour for street and especially lorry work. To appreciate the Clydesdale he must be seen at work in the single-horse lorry. He is not designed for such work as horses are put to in English towns. There the yoke is usually double, or 'unicorn', that is two abreast and one ahead, or fourfold, with two 'in the wheel' and two tracing these tandem-wise. These yokes are very common, in fact they are the rule in London and most great centres in England. In Scotland the four-wheeled lorry, weighing about 30 cwt. (112 lb. each) net, and capable of carrying from 3 to 3½ tons of a load, has to be negotiated by one horse, save on steep ascents, like Buchanan Street or West Nile Street, Glasgow, where a trace horse is provided. The Clydesdale has to shift a load varying from twice to, it may be, almost five times his own weight. To do this he must have more than pounds avoirdupois to recommend him, and in this is found the great determining factor in moulding the Clydesdale or Scots type of draught horse. Brains and spirit are of greater consequence than mere weight. The horse must be able to negotiate an ascent by sheer dint of will, zigzagging to get the better of his task. The ordinary Clydesdale gelding in sound working condition will weigh from 1700 to 2000 lb. The best class of such horses is reared in Aberdeen and the other northern counties of Scotland, and in Cumberland and Westmorland in the north of England. Carlisle is one of the best markets in the kingdom for this class of horse, and in Aberdeenshire there are still fairs at which large numbers of the very best types of cart horses are sold. Perth, as in respect of other classes of stock, is a great centre for the distribution of ordinary work horses. An auction sale for this class is held there every Monday throughout the year. Ayr is also a good market centre, and for young horses in autumn great sales are held at Perth, Lanark, Ayr, and Carlisle. Ordinary working Clydesdale geldings have frequently been sold for £100 and up to £120. These horses are usually about five years old, and up to big sizes and weights. Ordinary Clydesdale geldings for street traffic, five years old or thereby, make from £50 to £80 apiece.

Characteristics.—The Clydesdale is a very active horse. He is not bred for action, like the Hackney, but he must have action. But a Clydesdale judge uses the word with a difference. A Hackney judge using the word means high-stepping movement; a Clydesdale judge means clean lifting of the feet, not 'scliffing along', but the foot at every step must be lifted clean off the ground, and the inside of every shoe be made plain to the man standing behind. Action for the Clydesdale judge also means 'close' movement. The fore legs must be planted well under the shoulders—not on the outside like the legs of a bulldog—and the legs must be plumb, and, so to speak, hang straight from the shoulder to the fetlock joint. There must be no openness at the knees, and no inclination to knock the knees together. In like manner the hind legs must be planted closely together with the points of the hocks turned inwards rather than outwards; the thighs must come well down to the hocks, and the shanks from the hock joint to the fetlock joint must be plumb and straight. 'Sickle' hocks are a very bad fault, as they lead to loss of leverage.

A Clydesdale judge begins to estimate the merits of a horse by examining his feet. These must be open and round, like a mason's mallet. The hoof heads must be wide and springy, with no suspicion of hardness such as may lead to the formation of sidebone or ringbone. The pasterns must be long, and set at an angle of 45° from the hoof head to the fetlock joint. Too long a pastern is very objectionable, but very seldom seen. A weakness to be guarded against is what is termed 'calf knees', that is the formation from the knee to the ground which begins with the knee being set back, giving an appearance of angle which is delusive, because it is not the angle from the fetlock joint to the hoof head which relieves pressure on the foot, but an angle from the knee to the hoof head which is a weakness, and unsightly. A Clydesdale should have a nice open forehead, broad between the eyes; a flat, neither Roman-nosed nor 'dished' profile, a wide muzzle, large nostrils, a bright, clear, intelligent eye, a big ear, and a well-arched long neck springing out of an oblique shoulder, with high withers. His back should be short, and his ribs well sprung from the backbone, like the hoops of a barrel. His quarters should be long, and his thighs well packed with muscle and sinew. He should

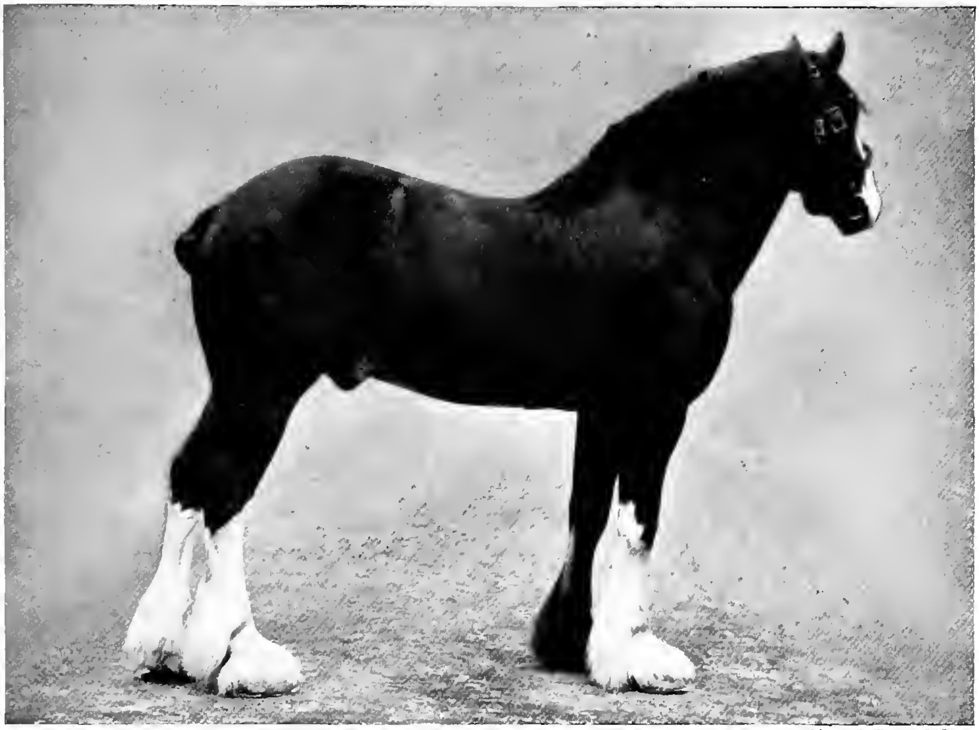


Photo. A. Brown & Co.

CLYDESDALE STALLION—"BARON O' BUCHLYVIE"
1ST IN OPEN CLASS OF AGED STALLIONS, H. & A.S. SHOW, 1908

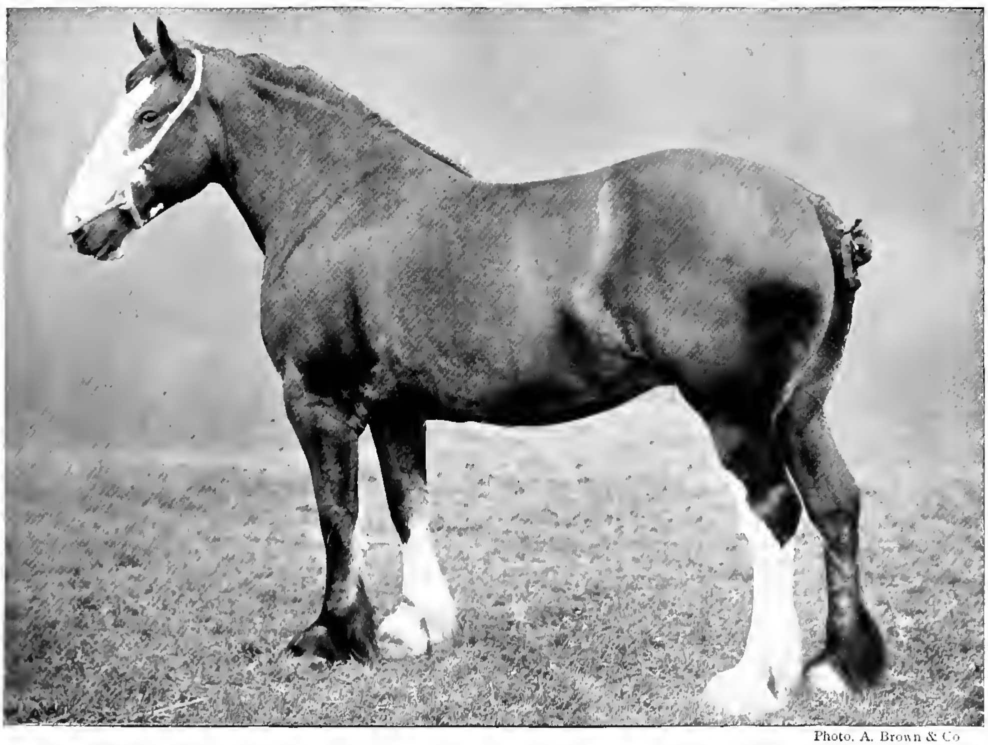


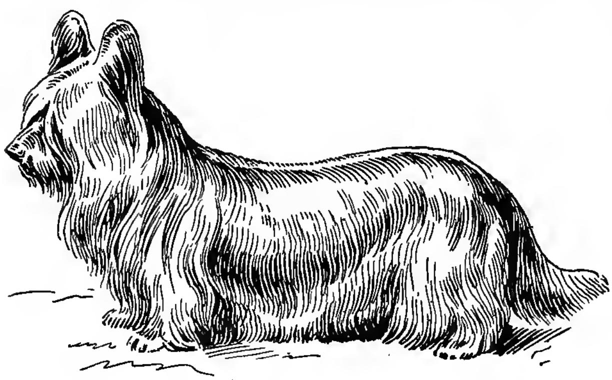
Photo. A. Brown & Co

CLYDESDALE MARE—"PYRENE"
FEMALE CHAMPION AT H. & A.S. SHOW, 1906

have broad, clean, sharply developed hocks, and big knees, broad in front. The impression created by a thoroughly well-built typical Clydesdale is that of strength and activity, with a minimum of superfluous tissue. The idea is not grossness and bulk, but quality and weight.

The ideal colour for a Clydesdale is bay or brown, with a more or less defined white mark on the face, dark-coloured fore legs, and white hind shanks. Chestnuts are hardly ever seen among Clydesdales; blacks are a little more common now than formerly. [A. M'N.]

Clydesdale Terrier. — This extremely beautiful variety of dog is very closely assimilated in shape to the Skye Terrier, the description of which may be referred to with advantage. The main point of difference that exists between them lies in the character of their coats, the jacket of the Clydesdale being of a silken texture and more of a silver-grey hue than that of some Skyes. The question of the shade of the coat, however, is not a matter of great importance, as it varies in individual animals, but in the case of the variety under consideration it is essential that it should be profuse and also silky to the touch. This softness of his coat renders it difficult for the Clydesdale to undertake any of the hard work underground or elsewhere which falls to the lot of so many terriers, as his delicate jacket provides no protection from cold or damp, and his energies would in consequence be numbed by exposure. At the same time the Clydesdale Terrier is no coward, rather the reverse, and he can therefore be recommended as an excellent dog for those who require something beautiful about them as a companion, and do not propose devoting him to hard work out-of-doors. They may be reminded, however, that the coat of the Clydesdale requires a good deal of attention if it is desired that the dog should look at his best, for it must be remembered that the softer and finer a luxuriant jacket is, the greater its tendency will always be to become tangled and unkempt. As a consequence, those who propose cultivating the Clydesdale Terrier must be prepared to devote some time and care to the treatment of their dogs' coats. [V. S.]



Clydesdale Terrier

Clyers. See Mesenteric Diseases.

Clytus arietis (the Wasp Beetle). — This wasplike beetle is black, with yellow bars and spots on the elytra, yellow and black legs, and long antennæ; length, $\frac{1}{2}$ to $\frac{2}{3}$ in. It is found crawling on hedges and in gardens. The larva feeds in dead and decaying wood, stumps, and posts, and also in sound wood. Some naturalists look upon it as beneficial, as it is said to attack other wood-boring larvæ. [F. V. T.]

Cnicus (Plume Thistles), a generic name sometimes applied instead of *Cirsium* to all those thistles whose fruit is crowned with feather-like hairs. See Cirsium and Carduus. [A. N. M'A.]

Coach. See Carriage.

Coagulation is the term applied to the process of separation or precipitation from solution of certain substances in a solid state, either by warming or by the addition of some reagent. One of the best-known phenomena of this kind is the curdling of milk. If rennet is added to fresh milk a white flocculent solid soon separates out, called the milk curd. This curd consists largely of casein, which before the rennet was added existed in solution in the milk. The rennet contains an enzyme or ferment, which splits the casein up into two derivatives, one of which forms an insoluble salt with the element calcium and separates out as the curd. Again, if milk is kept for some days in warm weather, natural curdling or coagulation of the casein takes place. In this latter case the cause of the precipitation of the casein is due to the formation of an acid, namely lactic acid, in the milk. Heat often causes liquid substances to separate in a solid form, a good example of which is the formation of white of egg from the semi-liquid state by warming. Many other examples of either a physical or chemical nature could be taken to illustrate coagulation. [R. A. B.]

Coal. See Fuels.

Coal Gas. See Gas and Gas Plants.

Coccidæ (Scale Insects), a family of hemipterous insects related to the plant lice. They are of the greatest importance to fruit growers, foresters, and gardeners, on account of their destructive nature. Such serious pests as the San José Scale, Mussel Scale, Ash Scale, Felted Beech Coccus, and Mealy Bugs belong to this group.

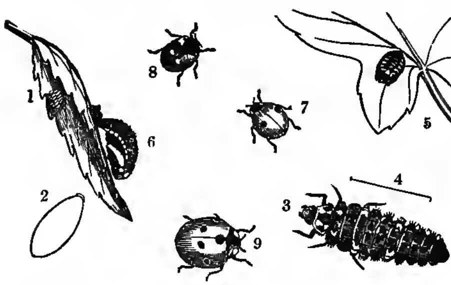
The majority are protected by a waxy covering or 'scale', but some are nude (Mealy Bug); others have a coat of waxy threads (Beech Coccus). The eggs give rise to active six-legged larvæ. The female is usually sedentary, and loses legs and antennæ, remaining hidden under the scale beneath which she deposits her eggs. The male 'scale' is smaller, and the mature male has a single pair of wings, hatching out from the scale and flying about amongst the females. The mouth of the Coccid is very long and thread-like, and by its means they suck out the sap of

trunk, boughs, leaves, and fruit. Reproduction is frequently asexual. Many have a world-wide distribution, having been distributed with the plants, such as the Mussel Scale.

They are best destroyed by fumigation with hydrocyanic acid gas and washing with paraffin emulsion (see CRYPTOCOCCUS, DACTYLOPIUS, MYTILASPIS, PULVINARIA, LECANIUM, &c.). [F. V. T.]

Coccidium oviforme (Liver Rot in Rabbits).—This microscopic parasite belongs to the lowest group of animals, called Protozoa, and to the order Coccidiidæ. The pale spots found on the liver of the rabbit are caused by this Coccidium, which reproduces in the tissue of the liver, the spores being passed out in the excreta, and fall upon grass and in water, and are then taken up by other rabbits. It is sometimes epizootic, and causes considerable mortality in both wild and domesticated rabbits. [F. V. T.]

Coccinella (Ladybirds), a genus of beetles belonging to the family Coccinellidæ, pre-emi-



Coccinella—Ladybirds.

1. Cluster of eggs. 2. Egg (greatly magnified). 3, 4. Larva (magnified and nat. size). 5, 6. Pupæ. 7, 8. Varieties of Two-spotted Ladybird (*C. bipunctata*). 9. Seven-spotted Ladybird (*C. septempunctata*).

nently serviceable in destroying plant lice or aphides. These pretty creatures, some of which are very well known, deposit their eggs under the leaves. These soon produce little black larvæ (often called 'niggers'), which immediately search for the aphides, being not infrequently surrounded by them, and these speedily fall victims to their voracity, until the leaf on which they were born is cleared. Having changed their skins, as they increase in size they disperse, and thus a plant or bush is sometimes perfectly freed from the blight. When the larvæ are full grown, they remain motionless, attach their tails to a leaf, or creep into a chink of a tree, and change to pupæ; from these the ladybirds emerge in about a fortnight in summer; but the autumn broods often remain in that torpid state until the spring; and the beetles hibernate also. The shining yellow eggs are gummed together in clusters, as in fig. 1 (an egg, magnified at 2). The larvæ are black or slate-coloured, with six rows of black spiny tubercles; the head and thorax are orange, spotted with black, and there are three or four scarlet spots on the body; they have six short legs (as in fig. 3). The pupæ are curved, blackish, variegated with orange (5 and 6). The most abundant species are the following:—

C. septempunctata, one of the largest ladybirds of this genus. It is black, with a whitish spot on each side of the thorax; the elytra are red, with seven black spots. It is found feeding on all aphides in gardens and woods.

C. ocellata is frequent in hop gardens, and also feeds upon larch and other coniferous aphides. It can be told by the eight black spots on the elytra being surrounded by a pale-yellowish rim. It also feeds upon scale insects. [J. C.] [F. V. T.]

Cochineal, a dyestuff consisting of the dried bodies of a scale insect (*Coccus cacti*), native of Mexico, Guatemala, &c., now specially produced throughout Central and South America, the West Indies, the Canary Islands, Algeria, and to a less extent Spain, Java, India, &c. There are two forms of the insect, known as the *Grana fina*, which feeds on the true Nopal Cactus or Cochineal Fig (*Opuntia coccinillifera*), and the *Grana sylvestris* (on *O. monacantha* and *O. Dillenii*, the Prickly Pear). Rearing depends on the possibility of food supply, hence if the Nopal does not exist naturally, it must be capable of easy production. A danger lies in the plant becoming a troublesome weed. This has proved the case in India, where the less desirable species of prickly pear has overrun large tracts of country. The insect is viviparous, and the male and female larvæ are not distinguishable. They become fixed on the cactus, lose the power of locomotion, and assume the form of round grains—the dye-yielding particles of commerce. In due time from the aggregated masses of these larval cases a few male winged insects emerge, and fly off to visit the remaining female wingless insects, and thereafter die. 'Nesting' consists in picking out certain impregnated female cases and carrying these off to fresh nopal plants shortly before the breeding season. Killed and dried females constitute the dye grains of Cochineal, and are collected before the emergence of the larvæ. There are three grades, depending chiefly on the method of drying and the care bestowed in their preparation; these are known as 'silver-grey' (the finest grade), 'black', and 'granilla'. Cochineal gives fine crimson and scarlet dyes, but its production has decreased greatly since the introduction of the aniline colours. [G. W.]

Cochin Fowl.—With the exception of the Game Fowl, no breed of poultry has had so much influence upon poultry breeding in the United Kingdom as the Cochin, and with no great justification, for it is very deficient in those economic properties which make for profit in the supply of eggs and chickens for food. Introduced from China in 1845 under the name of Shanghai, it was the direct cause of the boom in poultry keeping which marked the mid-years of the 19th century, when fabulous prices were given for specimens, and exhibitions were fashionable to an extreme. That mania did not continue for long, but the influence remained, as it led to the establishment of the show system, which has occupied so important a position in this country, and which yet forms a considerable factor in relation to the breeding of domestic poultry.

The Cochin is one of the largest fowls we have,

adult males often attaining the weight of 12 and 13 lb. It is heavy boned, broad and massive in frame, with a short back, from which the neck and tail rise almost abruptly, and the short legs give it a very compact appearance, whilst as it is heavily feathered the size is greatly added to. The feathering is not alone on the body, but extending to the hocks, legs, and feet. Modern breeding has all been in the direction of increasing this profuseness of feathering, and as a consequence towards decrease of economic qualities. The neck is short, the head small, and the comb single. The flesh and skin, the beak and legs, are yellow; the wings are small, and the amount of meat on the body is correspondingly limited, such as there is being chiefly on the thighs, and as a consequence poor in flavour. There are in all five varieties, or colours, namely, Buff, Partridge, White, Black, and Cuckoo, the first named of which is more common than the others. The hens produce somewhat small eggs, as there is no correlation between the size of body and of egg produced, but these are beautifully tinted in shell, rich in flavour; and although the number laid by each individual hen compares unfavourably with other breeds, the Cochin may be regarded as a good winter layer. They are quiet in disposition, become brood yearly, are splendid sitters, but, owing to the amount of feathers upon the legs and feet, are awkward when with chickens. As might be supposed, these birds are big eaters, and that fact combined with their limited egg productiveness makes them unprofitable to keep except for exhibition purposes. [E. B.]

Cochlearia, a genus of cruciferous plants, having nearly globose pods, very convex valves, and numerous flat seeds containing an embryo so doubled up that its radicle lies along the edges of the seed leaves.

C. armoracia (Horse Radish; *Raifort*, Fr.) is a well-known perennial with thick, woody, root-like stems, which strike deep into the ground and readily produce buds. Hence the plant is easily propagated by a small cutting from this underground stem. Horse radish grows naturally in moist places over all the northern and midland parts of Europe, delighting in a deep rich soil; in England it has been found apparently wild in South Wales, Yorkshire, and Northumberland; but it is difficult to say whether a plant which has been cultivated from time immemorial is indigenous or not. It produces its coarse, oblong, blunt leaves in the early spring; and by May its numerous clusters of small white flowers are expanded. Pods rarely succeed the flowers in this country.

The pungency of the underground stem of this plant is what gives it value as a seasoning to unctuous dishes. That peculiar quality disappears when the root becomes dried, and is diminished by keeping above ground; the roots should, therefore, be used as fresh as possible.

The plant grows so readily anywhere that it is seldom thought worthy of special cultivation except by market gardeners. All that it requires is a shady corner in any deep, rather moist soil, not overmanured. It is propagated by pieces of the underground stem dibbled in in February. The strongest crowns of old plants should be taken for this purpose, and cut into pieces 2 in. long. These are to be put to the bottom of holes 18 in. deep; and the holes themselves must be filled in with cinder siftings, or coarse charcoal, or some material which will allow air to reach the buried crowns. When once established, it is merely necessary to trench, in autumn, the place where the horse radish grows; to take out the large roots and put them aside in earth for winter use, and then to fill in the place with the same soil, adding a little very rotten manure at the lowest part of the bed, before the earth is put back; the small pieces left in the ground will provide materials for a succeeding crop. The roots put aside for use should be examined from time to time, and all sprouts removed as soon as they appear. Serious cases of poisoning have occurred from mistaking the aconite root for that of horse radish.

[J. L.] [A. N. M'A.]

Cock. — This term is given to adult males of fowls and turkeys, usually when they have reached one year old, although for exhibition purposes it is customary to so designate the male birds hatched the previous season on and after January 1st in each year (see COCKEREL). [E. B.]

Cockchafer. See MELOLONTHA VULGARIS.

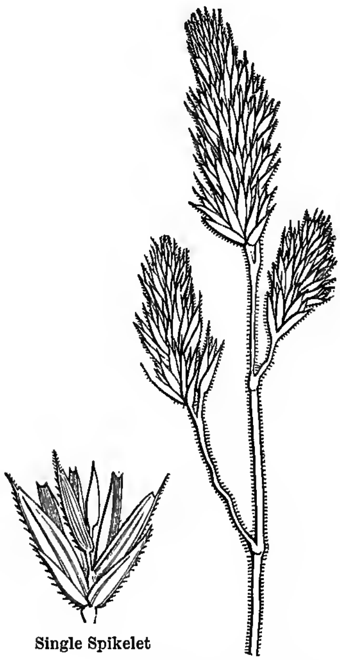
Cockerel.—The name given to under year males, but, as already stated (see COCK), for exhibition purposes it is not usually given after December 31st of the year in which they are hatched. [E. B.]

Cock Fighting. See ANIMALS, CRUELTY TO.

Cockroach.—The Cockroach belongs to the group Orthoptera, and is characterized by having a flattened, elongated, oval-shaped body, the external covering of which is composed of hard chitinous material. The antennæ are very long, and the legs are specially adapted for running. A pair of tough leathery elytra protect the larger membranous wings underneath. The metamorphosis is incomplete, that is, the larvæ resemble the perfect insect except in that the wings are shorter. The two commonest species of the Cockroach are *Blatta orientalis*—the common house Cockroach—and *Periplaneta* (or *Blatta*) *americana*, the latter being the larger. Both are nocturnal in their habits, and devour all kinds of food. A ready means of eradicating these pests is to supply them with poisonous food, such as meal moistened with treacle and containing arsenic, corrosive sublimate, or red lead. [R. H. L.]

Cocksfoot (*Dactylis glomerata*). — This is a perennial masterful grass with large broad leaves, which soon become rough and harsh. Its shoots do not creep, but form a large fan-shaped tuft, and when cut down, new shoots appear with such rapidity that Cocksfoot is said to 'grow under the scythe'. The ear-bearing straws reach a height of 2 or 3 ft. The ears themselves are in flower by June or July, and in seed by the month of August. The ear is a heavy one, and the straw which bears it coarse and wooden; accordingly this grass is unsuitable for hay meadows. It is for permanent pasture that

Cocksfoot is suitable, and in seeding for such, a moderate proportion, say 3 lb. of Cocksfoot seed per acre, should always be included. This



Cocksfoot (*Dactylis glomerata*)

grass is met with on all kinds of soil; one may even notice stunted forms growing alongside of mosses on old walls. If properly managed and well grazed, Cocksfoot takes its place in the first rank of forage grasses, for it is a heavy yielder, readily eaten, grows rapidly, and on all classes of soil is very permanent, holding its own, and sometimes more than its own, with the competing grasses, even with the weeds alongside.

In a pasture, Cocksfoot grass is easy to identify, for it is the only broad-leaved grass whose shoots show *flat and broad* at the part pulled out of the ground. The shoots of Meadow grasses (Poa) are also flat, but then they are quite narrow, and the leaf-blades on them are quite small. When in ear, identification is again easy, for the spikelets grow in tufts at the ends of the branches of the axis, as shown in the figure. One spikelet is shown detached, and when this is ripe it breaks up into several pieces, each composed of a little stalk and a two-valved husk enclosing a grain fruit. Each of these detached pieces is called a 'seed', although it is not a seed at all. When describing such seeds it is convenient to name that valve of the husk which lies next the stalk as the upper valve, and that other away from the stalk as the lower valve on the back of the seed. These 'Cocksfoot seeds' cannot lie on their back, for the lower valve of the husk (*lower pale*) is V-shaped and not rounded. This feature, taken in conjunction with the fact that the apex of this lower valve forms a sharp point slightly *bent to one side*, suffices to distinguish Cocksfoot seed from that of other grasses. Any seed that has the lower valve of its husk rounded and can lie on its back is certainly not the seed of Cocksfoot. From 20 to 28 lb. of pure germinating seed would be required to crop an acre with Cocksfoot alone; accordingly the inclusion of 3 lb. of Cocksfoot seed in a mixture for an acre means covering about one-tenth of it with this grass. [A. N. M'A.]

Cocoa. See CACAO.